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FIFTIETH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

R. Y. WINTERS, Director

THE NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

AND

STATE DEPARTMENT OF AGRICULTURE, COOPERATING

STATE COLLEGE STATION
RALEIGH

FOR THE
FISCAL YEAR ENDED JUNE 30, 1927
STATISTICAL SUMMARY FOR YEAR ENDING DECEMBER 1, 1927

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STATISTICAL SUMMARY FOR YEAR ENDING DECEMBER 1, 1927

OWEN G. DUNN, PRINTER, NEW BERN, N. C.

LETTERS OF SUBMITTAL

January 26, 1928.

PRESIDENT E. C. BROOKS,
North Carolina State College of Agriculture and Engineering,
State College Station, Raleigh, N. C.

DEAR SIR:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering. The report contains a summary of the activities and results accomplished during the fiscal year ending June 30, 1927.

Respectfully yours,
R. Y. WINTERS, *Director of Research.*

STATE COLLEGE STATION, RALEIGH, N. C.,
February 2, 1928.

HON. A. W. MCLEAN,
Raleigh, N. C.

MY DEAR GOVERNOR:

I take pleasure in transmitting to you the annual report of Dr. R. Y. Winters, Director of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering, for the year ending June 30, 1927.

The report this year shows definite accomplishments along the various lines of research undertaken by the staff of the Experiment Station. Progress has been made with all projects and the farmers of the State continue to look to this Station for leadership in solving agricultural problems.

Very sincerely yours,
E. C. BROOKS, *President.*

EXPERIMENT STATION COMMITTEE

(Appointed by Board of Trustees of College)

B. F. Shelton, Speed, N. C.
Clarence Poe, Raleigh, N. C.
David M. Buck, Bald Mountain, N. C.

(Appointed by State Board of Agriculture)

W. A. Brown, Rocky Point, N. C.
R. W. Scott, Haw River, N. C.
E. G. Roberson, Leicester, N. C.

JOINT COMMITTEE ON AGRICULTURAL WORK

(Appointed by Board of Trustees of College)

Robert N. Page, Southern Pines, N. C.
W. D. Laroque, Kinston, N. C.
J. F. Diggs, Rockingham, N. C.
Charles W. Gold, Greensboro, N. C.

(Appointed by State Board of Agriculture)

Clarence Poe, Raleigh, N. C.
O. Max Gardner, Shelby, N. C.
J. Vance McGougan, Fayetteville, N. C.
R. W. Scott, Haw River, N. C.

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OFFICERS AND STAFF

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

JANUARY 1, 1928

E. C. Brooks ..... *President of the College*
I. O. Schaub ..... *Dean of the School of Agriculture*
R. Y. Winters ..... *Director*
C. B. Williams ..... *Vice-Director*
*F. E. Miller ..... *Director of Branch Stations*
F. H. Jeter ..... *Agricultural Editor*
A. F. Bowen ..... *Treasurer*

Agronomy

S. R. Bacon ..... *Assistant in Soil Survey*
*F. O. Bartel ..... *Drainage Engineer, in Co-operation with U. S. Department of Agriculture*
A. S. Cline ..... *Assistant in Soil Fertility Investigations*
W. A. Davis ..... *Assistant in Soil Survey*
G. M. Garren ..... *Assistant in Plant Breeding*
R. C. Journey ..... *Assistant in Soil Survey, in Co-operation with U. S. Department of Agriculture*
P. H. Kime ..... *Assistant in Plant Breeding*
W. B. Lee ..... *Assistant in Soil Survey, in Co-operation with U. S. Department of Agriculture*
H. B. Mann ..... *Assistant in Soil Fertility Investigations*
E. G. Moss ..... *In charge Tobacco Invesigations for the State Department of Agriculture and U. S. Department of Agriculture*
J. H. Moore ..... *Assistant Cotton Technologist*
C. B. Williams ..... *Agronomist*
L. G. Willis ..... *Soil Chemist*
R. Y. Winters ..... *Plant Breeder*

Animal Industry

R. S. Curtis ..... *Animal Husbandman*
C. D. Grinnells ..... *Dairy Investigator*
J. O. Halverson ..... *In Charge, Animal Nutrition*
E. H. Hostetler ..... *Swine Investigator*
R. H. Ruffner ..... *Head, Animal Industry*
C. D. Schiffman ..... *Assistant in Animal Nutrition*
F. W. Sherwood ..... *Associate in Animal Nutrition*

Botany

S. G. Lehman ..... *Plant Pathologist*
R. F. Poole ..... *Associate Plant Pathologist*
B. W. Wells ..... *Botanist*

Horticulture

C. D. Matthews ..... *Horticulturist*
M. E. Gardner ..... *Assistant Horticulturist*
Robert Schmidt ..... *Assistant Horticulturist*
C. F. Williams ..... *Assistant Horticulturist*

Poultry Husbandry

R. S. Dearstyne.....*Associate Investigator and Pathologist*
B. F. Kaupp.....*Poultry Investigator and Pathologist*
W. G. Crowder.....*Poultryman*

Zoology and Entomology

*C. S. Brimley.....*Assistant Entomologist*
*J. C. Crawford.....*Assistant Entomologist*
*J. A. Harris.....*Assistant Entomologist*
*R. W. Leiby.....*Entomologist*
Z. P. Metcalf.....*Entomologist*

Agricultural Economics

G. W. Forster.....*Economist*
R. J. Saville.....*Assistant in Economics*

Rural Sociology

W. A. Anderson.....*Sociologist*
J. A. Shanklin.....*Assistant Sociologist*

Central Stations

R. J. Harris.....*Foreman*
F. E. Miller.....*Director of Branch Stations*

*Branch Stations

F. E. Miller.....*Director of Branch Stations*
R. E. Currin, Jr.....*Assistant Director, Upper Coastal Plain Station, Rocky Mount, N. C., Rt. 5*
F. T. Meachan.....*Assistant Director, Piedmont Branch Station, Statesville, N. C.*
S. C. Clapp.....*Assistant Director, Mountain Branch Station, Swannanoa, N. C.*
Charles Dearing.....*Assistant Director, Coastal Plain Branch Station, Willard, N. C.*
E. G. Moss.....*Assistant Director, Tobacco Branch Station, Oxford, N. C.*
J. L. Rea, Jr.....*Assistant Director, Blackland Branch Station, Wenona, N. C.*

* Workers and Branch Stations under authority of the State Department of Agriculture, co-operating with the Agricultural Experiment Station in Research.

FIFTIETH ANNUAL REPORT OF THE NORTH CAROLINA EXPERIMENT STATION

The research work in the School of Agriculture includes investigations of the Agricultural Experiment Station and additional projects conducted by the teaching staff of the School. The work of the Experiment Station is conducted in co-operation with the State Department of Agriculture. Results secured from this work are essential to undergraduate and graduate instruction and to Agricultural Extension.

PROGRESS

At no time in the history of agricultural research has its findings been better appreciated or more earnestly sought. This has been manifested by the large number of letters requesting specific information and the expressions of appreciation for services rendered. The research staff has

A partial view of the visitors at the annual field day and farm picnic held on the Coastal Plain Station in late September. Over 5,000 persons attended this event.

taken advantage of this attitude by making special efforts to present available information at timely intervals. These efforts have taken form in the co-operation of research workers with the Extension Service and the Department of Agriculture in the conducting of special field meetings at the Branch Station farms and at other points. The meetings have had for their purpose the presentation of practical results from the research work. These field meetings have offered to the farmers special days for the study of experimental results with sweet potatoes, small grain,

tobacco, swine feeding, dairying, poultry, and cotton production. The meetings have been well attended by county agents, vocational teachers, and farmers. In several cases farmers have requested that these special meetings be held annually. The research workers have also made a special effort to prepare for publication information accumulated during the past few years. Eight bulletins are now prepared for publication but cannot be made available to the public on account of the lack of funds for printing. This emergency has been met to some extent by the Division of Agronomy, and a few other groups, by issuing several mimeographed circulars. The Botany Department has prepared for publication results of a comprehensive study entitled, "A Southern Upland Grass-sedge Bog Succession", which should be published as soon as printing funds can be made available.

The regularly approved program has been pursued with considerable interest and with a splendid spirit of co-operation between departments. The Department of Agricultural Economics has continued its study of farm organization and management in Northampton County where careful records are being taken on the present practice of typical farms in that county. Beginning January 1 of this year the work of reorganization of certain of these farms was started. It is the purpose of this work to render the farms more efficient by a readjustment of their cropping and livestock operations to a better utilization of available land and labor. Records are being taken on the readjusted farms for the purpose of measuring the value of such adjustments.

The Agronomy Department has made the results of their recent research very effective by the preparation of fifteen mimeographed circulars covering such subjects as fertilizer requirements of North Carolina soils, varieties of field crops for different sections of the state, lime requirements of soils, cotton spacing, etc. Through the co-operation of the Publicity Department these circulars have had a broad circulation and have met with favor among county agents, vocational teachers and farmers. The recent studies concerning magnesia deficiency in several soil types indicate that this element may play an important part in crop production on certain Piedmont and Coastal Plain soils. Further field studies are planned for this season, but the more careful attacks of this problem await the construction of a research greenhouse. The study of certain physical properties of the cotton fiber in relation to its spinning value and cotton improvement has yielded interesting results. This work was done in co-operation between the Department of Agronomy and the Textile School. The results indicate that the value of strong "drag" as a means of predetermining spinning qualities of cotton has been overrated by the trade.

The Animal Industry Department has co-operated with the Federal Department of Agriculture and departments of six other states in contributing to our knowledge of soft pork problems. Some of these findings have recently been published in the U. S. Department of Agriculture bulletin No. 1492, entitled "Some Results of Soft-Pork Investigations, II". Other contributions of the Animal Industry group include additional information upon sheep management, permanent and temporary pastures for swine, the use of cottonseed meal for feeding swine, the value of home grown roughage and concentrates for North Carolina dairy cows.

On January 1st of this year Prof. Earl Hostetler was authorized to take charge of the beef cattle and sheep investigations, succeeding Prof. R. S. Curtis. Prof. Hostetler will, under the new management, have charge of the beef cattle, sheep and swine investigations. Mr. J. E. Foster, a graduate of this institution with post graduate work at the University of Kansas, has been appointed as assistant in the beef cattle and sheep work.

The group in the Department of Botany have been active in the study of seed borne diseases, diseases of sweet potatoes in relation to field infection and storage, dewberry diseases, and those common to soybeans. The results of their findings have been published in several technical papers, and the practical phases presented in news articles and meetings.

Three years ago the Station received a resolution from tobacco growers of Edgecombe, Pitt, Greene, Martin, and Wilson counties requesting relief from the damages of tobacco mosaic. This disease is reported to have done no less than two million dollars damage to the tobacco crop of the past year. The Botany Department has planned to give this problem special attention. The proposed greenhouse equipment for this department will be of much value in the study of this and other crop disease problems.

Mention has already been made of the results secured in the study of an upland bog in the eastern part of the state conducted by Professors Wells and Shunk. I hope provision can be made for publishing this information.

In the Department of Entomology and Zoology most of the research work has been conducted by the teaching staff, there being no full time research workers in that department at this time. Their projects have been concerned with the study of the life history and control of corn ear worms, corn root worms, leaf hoppers and Mexican bean beetles. Some time has also been given to the study of honey bees of the state, wintering of honey bees, and honey producing plants. The zoological group of this department have been interested in studies concerning the inheritance of blood groups in man, inheritance of mental traits in mammals, and multiple factors of inheritance in invertebrates.

Provision has been made for strengthening the entomological research by the appointment of Dr. B. B. Fulton, who will do full time research work beginning May 1st. Mr. D. L. Wray has been appointed as temporary assistant in the department to do special work on the corn ear and root worms.

The Department of Horticulture is studying problems related to the production and storage of apples, peaches, grapes, pecans, dewberries, strawberries, sweet and Irish potatoes. The results from some of these projects have matured sufficiently to materially influence the methods ordinarily practiced in the state. Among these are the pecan investigations, pruning and training young apple trees, peach thinning, sweet potato culture, sweet potato storage, and Irish potato investigations.

In November, 1927, Mr. M. E. Gardner was appointed assistant in horticultural research to take the position left vacant by the resignation of W. A. Radspinner. Mr. Gardner will have active charge of fruit and truck investigations at the Piedmont and Mountain Branch Stations.

The Poultry Department has been engaged in the study of poultry diseases, their influence upon the poultry industry and their control.

Additional information has also been secured in the feeding, management and breeding as applied to home and commercial flocks. This department has completed for publication two bulletins, one concerning the cost of producing eggs and the influence of roup upon egg production, and a second which describes a new disease of poultry. The publishing of these bulletins must await available funds for that purpose.

The Poultry Department has been very much handicapped in the pursuit of their disease studies. It has been necessary to isolate the diseased birds and former facilities for isolation have exposed the diseased flock to thieves. During the past year a permanent site was located on the farm and a new plant constructed which will give ample protection and better facilities for the execution of this important work.

In the field of Rural Sociology some interesting and valuable data have been secured upon the standard of living among Wake county white landowners and tenants. The data secured from this project will furnish reliable information upon the source of income for landowners and tenants, the purposes for which the income is spent, and the utilization of time on the farm.

THE STATION ANNIVERSARY

April 19th of this year marks the fiftieth anniversary of the founding of the Agricultural Experiment Station. Ours was the first station of the kind to be established in the South and the second in the Union. Since the day of its origin the Experiment Station has initiated and fostered many of the important agricultural movements and changes in the agricultural practices of the state. Plans are now under way for the appropriate celebration of this the fiftieth anniversary of its service to the agriculture of our state.

FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture and sales from the Station farms with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

In Account with the UNITED STATES APPROPRIATION, 1926-1927.

	Dr. Hatch Fund	Adams Fund	Purnell Fund
To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1927, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund)	$15,000.00	$15,000.00	$30,000 00

			Cr.
Salaries	$13,454.66	$13,020.00	$16,653.23
Labor	126.19	340.58	2,774.12
Stationery and office supplies	304.80		211.64
Scientific supplies, consumable	102.37	308.53	320.58
Feeding stuffs			5,496.99
Sundry supplies	5.01	357.59	691.61
Communication service	10.57		2.13
Travel expenses	699.33	471.73	1,455.61
Transportation of things	6.08	68.44	47.33
Heat, light, water and power	5.00	34.63	
Scientific equipment	285.99	398.50	245.25
Livestock			2,101.51
	$15,000.00	$15,000.00	$30,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

In Account with FARM AND MISCELLANEOUS RECEIPTS.

	Dr.
State Department of Agriculture	$60,000.00
Sales	13,085.06
Bank Overdraft	4,651.94
Total	$77,737.00

	Cr.
Salaries	$41,287.61
Labor	8,256.44
Stationery and office supplies	538.36
Scientific supplies, consumable	478.40
Feeding stuffs	4,127.93
Sundry supplies	1,994.23
Fertilizers	552.54
Communication service	843.39
Travel expenses	8,147.52
Transportation of things	351.72
Publications	498.92
Heat, light, water and power	706.27
Furniture, furnishings, and fixtures	403.80
Library	450.09
Scientific equipment	343.80
Livestock	2,041.50
Tools, machinery, and appliances	593.42
Buildings and land	1,452.71
Contingent expenses	4,668.35
Total	$77,737.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended

June 30, 1927; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was NOTHING on the Hatch Fund and NOTHING on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the Act of Congress of March 2, 1887, $15,000.00 under the Act of Congress of March 16, 1906, and $30,000.00 under the Act of Congress of February 24, 1925, and the corresponding disbursements $15,000.00, $15,000.00, and $30,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of NOTHING, NOTHING, and NOTHING, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed) W. T. DIXON,
A. H. HOWELL,
Auditors.

(Seal)
Attest:
A. F. BOWEN,
Custodian of the Seal.

RESEARCH IN AGRONOMY

The research work of the Department of Agronomy during the past year has been continued along the lines of soil chemistry, soil fertility, crop rotation, soil classification and mapping, plant breeding and field experiments to determine the relative value of different cultural methods in crop production.

Research in soil chemistry has been mainly centered in a study of the magnesia and manganese deficiencies of certain important soil types of the state; the effects of heavy liming upon the absorption of other plant nutrients in muck soils; and in the cause for winter-injury of peach trees in the sand-hill section of the State.

Soil fertility work is being carried out on nineteen outlying soil type fields, and at the Central and six branch stations. This phase of research of the Department is mainly concerned with determining by field experiments the chief plant-food deficiencies of major agricultural soil types, the best proportioning of plant-food constituents to most economically meet the needs of different crops grown on these different soils, as well as the best quantities to use and best sources of the different constituents. Considerable attention is being given to a study of the relative value of different methods of application, especially those carrying nitrogen, to different crops grown on various soil types.

A study is also being made of different systems of crop rotation and their influence upon the net annual returns, the physical condition and productivity of the soils, and upon the efficiency of lime and fertilizer.

The classification and mapping of soils in the State by counties in co-operation with the Federal Bureau of Soils has been pushed actively during the year. Reports on this work furnish the exact location of each soil type which is the basis on which practically all the field work in soil fertility and crop improvement is cast. By working on the soil type basis, one is enabled to make direct and definite application of the results secured in field experiments to each of these types occurring in other parts of the State. Any other plan of application of the results, it is felt, would be unsafe.

The results from carefully conducted crop improvement experiments has supplied many new varieties of crops of improved qualities and high yielding powers which are gaining favor with farmers of the State.

Much attention has been given to the study of methods of soil preparation, seed treatment, and spacing of crops and their influence upon the growth and yield of crops.

I. STUDIES OF SPECIAL SOIL PROBLEMS

Magnesia Deficiency of Sandy Soil Types. Research activities have been concentrated on the installation of a series of lysimeters and tile cylinders at the College to study the magnesia requirements of representative sandy soil types of the State. Preliminary work has been completed and experimental work was started on April 1 on this investigation.

Twenty-one treatments combining different amounts of lime and magnesia from mineral sources and with two forms of potash fertilizers

have been applied to each of two representative sandy soil types in the lysimeters. Duplicates of these treatments are applied to the same soils in 42 tiles in which crops are to be grown to be weighed and analyzed later.

Chemically pure fertilizing materials and approximately pure crystallized minerals were used for the soil treatments.

The apparent superiority on many soils of eastern North Carolina of dolomitic limestones over other forms low in magnesia has led to the belief that there is a widespread deficiency of magnesia in these soils which is accentuated by the use of high calcic limes. Results obtained during the past year indicate a possibility that manganese deficiency is quite prevalent in many soils and that the preference shown for the dolomites and a few local marl deposits may be based on their small content of manganese.

Fertility of Muck Soils. The possibility that the ill effects of heavy liming of muck soils in the State is due to decreased absorption of other plant nutrients has been made the basis of a study of the composition of corn plants from the lime test plats on the Blackland Branch Station farm. This was not completed at the end of the year, but the analyses will be finished as soon as pressure of other work permits.

Peach Winter-Killing. Analyses of soil samples taken from peach orchard plats in the sand-hill section of the State to a depth of four feet show that applications of nitrate nitrogen are rapidly leached from these soils by moderate rainfalls. There is some evidence that trees may be kept in thrifty condition by frequent applications of small amounts of nitrate of soda in addition to normal fertilization with nitrogen, phosphoric acid and potash in the spring.

Trees having died apparently from winter injury have been found to contain appreciable quantities of arsenic but evidence that this constitutes a primary cause of winter-killing is as yet inconclusive.

Additions of several minor nutrients to unthrifty trees in damaged orchards have resulted in no visible improvement.

Strawberry Fertilization Studies. The first crop of strawberries from the experimental plats at the Coastal Plain Branch Station farm in cooperation with the Soil Improvement Committee of the National Fertilizer Association was limited by late spring frosts and by extreme drought late in the picking season.

Insofar as the results of one season can be relied upon, it seems that frost and lack of moisture were the first limiting factors this year with the single exception that plats receiving cottonseed meal and fish scrap as sources of nitrogen were considerably more productive than were the check plats.

From results thus far obtained, it is evident that ground dolomitic limestone at the rate of one ton per acre decreases the size and quantity of berries.

IMPORTANCE OF LOCATING INVESTIGATIONAL WORK BY SOIL TYPES

For many years, this department has been centering its field research work by soil types, believing that this is the only scientific and safe way

to follow, as it has been found by chemical analyses and by field experiments that the plant-food deficiencies, fertilizer requirements and crop adaptations of many of these types were markedly different. These differences in adaptations and potentialities of different types should and do have a marked influence upon the nature of our recommendations. Below are given some facts bearing on this matter.

WIDE VARIATIONS IN PLANT FOOD DEFICIENCIES AND REQUIREMENTS OF SOIL TYPES

Iredell Loam. Main deficiencies are nitrogen and potash as shown by field results with cotton and corn, and by chemical analyses. In field trials, the use of phosphoric acid does little or no good on this type.

Cecil Clay Loam. Main deficiencies are phosphoric acid, nitrogen and potash in field results with cotton, corn and small grains, and by chemical analyses. Lime is necessary for best returns.

Norfolk Sandy Loam. Main deficiencies are nitrogen, phosphoric acid and potash as shown by field results, and by chemical analyses. Lime is not so necessary for best returns with this type as with Cecil clay loam.

Alamance Silt Loam. Main deficiencies are potash, phosphoric acid and nitrogen as shown by field results with cotton and by chemical analyses. This type and the Mecklenburg clay loam have shown as great or greater response to the use of potash than any other types found in the Piedmont region of the State.

Toxaway Loam. Main deficiencies are phosphoric acid, potash and nitrogen, and lime by field results with corn, small grains and Irish potatoes, and by chemical analyses.

Muck. Chiefly deficient in lime and potash as shown by field results with corn, oats and Irish potatoes.

SPECIAL CROP ADAPTATIONS TO DIFFERENT SOIL TYPES AND THEIR SIGNIFICANCE

The Department of Agronomy recognizes the fact that every agricultural soil type has not only its strong and weak points with reference to plant food resources, but firmly believes by the preponderance of field evidence that usually many of these possess certain characteristics and aspects which make it peculiarly suited for the growth of certain crops and for the practise of certain types of farming.

This special crop adaptation to soil types has been strikingly brought out time and again in the work of the Department during the past few years with many crops. Most every crop, for best growth, seems to have certain soil requirements which are best met by a certain soil type or of types closely related to it.

Several illustrations of special crop adaptation to soil types are tobacco, red clover, and other closely related legumes.

It has been known for a long time that tobacco of the highest quality is grown on certain types of soil.

Certain well-known types of the Norfolk, Durham, Alamance, Granville and Cecil series of soil must be used if most satisfactory results are to be secured. If set on other types, the quality of the tobacco is quite likely to suffer and the prices which it will command are lowered. This crop is very exacting in its soil requirements and if best results are to

be secured from its growth careful consideration should be given to the use of the type or types of soil best adapted.

It has also been observed that red and allied clovers do much better and are grown more generally in certain communities than in others in the same counties. In an effort to determine the cause or causes for this somewhat irregular distribution of red clover in Piedmont North Carolina, it has been found that its successful growth is closely associated with types of soil. The Davidson clay loam soil is especially adapted to the growth of red and allied clovers, for wherever one finds this type of soil well developed in the State, red clover will usually be found to be occupying a considerably larger proportion of the total acreage of the cultivated land than where there are other types of soil. With proper care in seeding alfalfa frequently attains its maximum success on this and closely related types of soil.

These observations are significant in pointing the way for a safe and sound plan of promoting the growth of special crops in North Carolina and for establishing untried types of farming, the success of which depends upon the successful growth of certain special crops. Especially is this true of those crops which appear to be rather exacting in their soil requirements like tobacco, red clover and alfalfa. The crops grown or attempted to be grown and the types of farming to be practised in any community are limited by the character of the dominant soils.

II. SOME RESULTS OF FIELD EXPERIMENTS SHOWING VALUE OF CROP ROTATION AND THE PLANT FOOD NEEDS OF NORTH CAROLINA SOILS

AT PIEDMONT BRANCH STATION (CECIL CLAY LOAM)

Crop Rotation Experiments. The crop rotation work consists of a study of the value of one-, two-, and three-year rotations of corn and wheat, with and without the use of legumes—cowpeas or soybeans and red clover, the fertilizer applications being the same with all rotations. Results for corn over a period of eight years shows a gain for the three-year rotation of 16.3 bushels over plats where continuous corn was grown. The two-year rotation has shown a gain of 11 bushels. Results for wheat, show a gain for the three-year rotation of 6.5 bushels over continuous wheat, while wheat in a two-year rotation gave a gain of 2.4 bushels over continuous wheat.

Fertilizer Work. The fertilizer experimental work at this farm is carried on for the purpose of determining the chief plant food deficiencies of this type of soil and finding the best proportions of fertilizing constituents for the different crops adaptable to the Piedmont region. A four-year rotation is followed on the two fields, each consisting of two series of plats. One-half of each series of plats is limed, the other half remaining unlimed. The rotation to be used on these plats is as follows:

First year —Cotton, rye
Second year —Corn, wheat
Third year —Wheat, red clover
Fourth year —Red clover

Results obtained over a period of seventeen years have shown that phosphoric acid is the main limiting plant food constituent for the profit-

able production of corn, cotton and wheat, with nitrogen ranking next in importance. Potash has a greater value in the growing of cotton than with the other two crops. Lime, phosphoric acid and potash have been found to be determining factors in the successful growth of red clover. For the past seven years, this crop has been a complete failure on the unlimed portion of the plats except on those that received a heavy application of phosphoric acid and potash. On the limed portion of the plats, phosphoric acid has given greater yields of red clover than has the use of the other two constituents.

Acid Phosphate vs Rock Phosphate. Results from field experiments continue to show that acid phosphate is a more efficient carrier of phosphoric acid than is rock phosphate, when both are used in sufficient quantities to supply normal amounts of phosphoric acid for the growing of corn, wheat and red clover.

Nitrogen Carriers. In this work, a comparison of the relative value of nitrate of soda, sulphate of ammonia, nitrate of ammonia, calcium cyanamid, sludge, cottonseed meal, leunasalpeter, and urea as carriers of nitrogen in a rotation of cotton and corn is being made. Results so far obtained show nitrate of soda, nitrate of ammonia, and sulphate of ammonia of about equal rank as carriers of nitrogen, with a very slight advantage in favor of nitrate of soda.

AT MOUNTAIN BRANCH STATION (TOXAWAY LOAM)

Soil Fertility Experiment. Results thus far secured in the soil fertility experiments at this farm show that phosphoric acid is the first and nitrogen

Dr. E. C. Brooks, of State College and Dr. J. I. Foust, of the College for Women, visited the Mountain Branch Station last year. Similar meetings were held at the Coastal and Upper Coastal Stations and are the forerunners of specialists' meetings to be held at each branch farm next summer.

the second limiting factor in the production of corn, wheat and Irish potatoes on this type of soil. Lime, when used with a complete ferti-

lizer, has proven profitable. When used alone it has given beneficial results with the legumes. A complete fertilizer has proven most profitable for Irish potatoes. The use of sulphate and muriate of potash as sources of potash, have given practically the same results, each having produced a higher yield than a fertilizer mixture containing kainit as the potash source.

Sources of Phosphoric Acid. Acid phosphate, finely ground phosphate rock, and basic slag are being used as source of phosphoric acid in a complete fertilizer applied to corn, wheat and red clover grown in rotation. Limed and unlimed plats are used in the series. Results obtained over an eight-year period are in favor of the mixture containing acid phosphate as compared with finely ground rock phosphate, on both the limed and unlimed plats. On the unlimed plats, basic slag has given a 36.7 per cent. better yield of red clover than has acid phosphate. On the limed plats, acid phosphate produced a ten per cent. greater yield than did basic slag. When corn was grown, the acid phosphate produced a 34.1 greater yield than did the use of basic slag on the limed plats. Wheat has given a larger yield, on both limed and unlimed plats, where basic slag was used, the difference being greater on the unlimed plats.

At Coastal Plain Branch Station (Norfolk Fine Sandy Loam)

Soil Fertility Experiments. The object of this experiment is to study the main plant food requirements of this type of soil for the successful growth of corn, soybeans, and oats-and-vetch.

Corn on the unlimed end of the experiment, as in previous years, responded best to nitrogen and phosphoric acid, with small amounts of potash slightly increasing the yields. On the limed end, however, potash played a very important part. A large percentage of the corn had broken over on this end. An examination of the roots of the stalks which were badly broken over showed the roots to be practically rotted away and the inside of the stalks for several inches above the ground were rotten. At the nodes there was a reddish discoloration, an accumulation of iron, which was more marked at the lower nodes and becoming less at the nodes above. The percentage of stalks affected in this way varied on the unlimed end from 5 to 15 per cent., while on the limed end of the plats from 10 to 75 per cent. The 15 per cent. down on the unlimed and the 75 per cent. down on the limed end were both on the plats that contained no potash in the mixture.

The effect of varying the amounts of potash on the percentage of stalks broken over just before maturity was as follows when 300 pounds per acre of the mixtures were used:

No. Plat	Formulas	Stalks, Percentage Broken Over	
		Unlimed	Limed
1	6-6-0	15	75
12	6-6-1	12	65
4	6-6-2	7	30
13	6-6-4	5	30
15	6-6-6	10	10

For oats and vetch for hay, nitrogen, phosphoric acid and potash are all essential but potash seems to be of least importance.

With soybeans, a complete fertilizer appears to be necessary containing larger percentages of potash than is necessary for best results with oats and vetch.

Lime applied broadcast at the rate of one ton per acre every three years has increased the yield of soybeans and corn, but has not increased the yield of oats and vetch grown on this type of soil.

Soil Type Experiment. In this experiment when a complete fertilizer is used, the same amount of nitrogen, phosphoric acid and potash is added each year as is removed by crops. The materials are applied singly, and in double and triple combinations. The largest yield was obtained from the use of all three plantfood constituents.

Lime applied at the rate of one ton every three years has not materially affected the yield of either corn, soybeans, or oats-and-vetch.

BLACKLAND BRANCH STATION (MUCK)

Sources of Phosphoric Acid and the Effect of Varying Percentages of Potash in Fertilizer Mixtures. The use of phosphoric acid applied in the form of rock phosphate, basic slag or acid phosphate has not materially increased the yields of either corn, Irish potatoes, or oats. The use of potash, however, doubled and tripled the yields of corn and Irish potatoes, as well as greatly increasing the yield of oat hay. Figures given below are the average of the results of four years, showing the effect of potash in the different fertilizer mixtures:

Crop	Fertilizer Analyses	Application per Acre—Pounds	Yield per Acre —Bushels
Corn	0-0-0	0	19.1
Corn	8-2½-0	400	17.9
Corn	8-2½-4	400	42.7
Irish Potatoes	0-0-0	0	54.4
Irish Potatoes	8-4-0	1000	50.4
Irish Potatoes	8-4-6	1000	111.8
Oat hay	0-0-0	0	2760 lbs.
Oat hay	8-2½-0	400	3274 lbs.
Oat hay	8-2½-4	400	5194 lbs.

It will be noted that the addition of 16 pounds of potash (K_2O) to 400 pounds of an 8-2½-0 mixture has increased the yields as follows:

Corn from 17.9 to 42.7 bus.
Oat hay from 3274 to 5194 pounds.

By adding 60 pounds of potash (K_2O) to 1000 pounds of an 8-4-0 mixture, the yield of Irish potatoes was increased from 50.4 to 111.8 bushels per acre.

As shown by these results, where a fertilizer was used containing no potash, the yields of corn and Irish potatoes were less than where no fertilizer was used. The results from this experiment show clearly that crops can not be produced profitably on this type of soil without the use of relatively high amounts of potash in the fertilizer mixtures.

Lime Experiment. A comparison of hydrated lime, ground limestone and marl when applied at the rate of 1, 2, 3 and 4 tons of calcium

carbonate equivalent per acre has shown ground limestone to be the most efficient source of lime. The use of 300 pounds per acre of an 8-2-4 fertilizer in addition to the ground limestone increased the yields in every instance. However, when the fertilizer was applied without the lime the yields were lower than when no fertilizer was applied.

Each succeeding year, larger yields are obtained on this soil from the use of fertilizers, provided the mixtures contain relatively high percentages of potash.

Cultural Treatment of Corn and Soybeans. There are two series of plats in this experiment, each series being rotated with corn and soybeans, thus giving a crop of each every year. The eight plats in each series are prepared for both crops as follows:

(1) Plowed 8 inches deep, level, not rolled.
(2) Plowed 8 inches deep, level, rolled.
(3) Disked 4 inches deep, level, rolled.
(4) Disked 4 inches deep, level, not rolled.
(5) Plowed 8 inches deep, ridged, not rolled.
(6) Plowed 8 inches deep, ridged, rolled.
(7) Disked 4 inches deep, ridged, rolled.
(8) Disked 4 inches deep, ridged, not rolled.

In all cases except plowing 8 inches deep and disking 4 inches deep, the same preparation which has given best results for corn did so for soybeans. Plowing 8 inches deep gave best results for corn, while disking 4 inches deep showed slightly better returns with soybeans. The results shown below are each an average of four plats for 1926 of both corn and soybeans.

Method of Soil Preparation	Yield Corn Bushels	Yield Soybeans Bushels
Plowing 8" deep	51.9	14.8
Disking 4" deep	47.4	15.4
Cultivated flat	52.1	18.2
Cultivated on ridge	44.8	11.9
Not rolled	50.7	16.0
Rolled	48.7	14.1

Results obtained from a similar cultural experiment conducted on this farm from 1922 to 1925 showed very definitely that deep plowing in which large quantities of subsoil were turned up to be harmful to the crop. However, plowing 8 inches deep was not deep enough to cause injury to the crops.

With both corn and soybeans, thus far cultivating flat has given decidedly larger yields than where the crop was planted and cultivated on a ridge. The unrolled portion of the field outyielded slightly the portion which was rolled.

UPPER COASTAL PLAIN BRANCH STATION (NORFOLK SANDY LOAM)

Concentrated vs. Low Analysis Fertilizers. Results obtained in previous years by comparing ready mixed concentrated fertilizers 16-8-8 and 18-6-6 used at the rate of 400 pounds per acre on cotton in the drill at planting, with mixtures analyzing 8-4-4 and 9-3-3 used at the rate of 800 pounds per acre, were substantiated by yields of the past year. The ready mixed

concentrated materials were just as effective as the less concentrated mixtures made from acid phosphate, manure salt and the ammonia derived one-half from cottonseed meal and one-half from nitrate of soda.

Sources of Nitrogen. In this experiment, in which the efficiency of nitrate of soda, leunasalpeter, urea, sulphate of ammonia, calcium nitrate, cyanamid and cottonseed meal are compared as the sole source of nitrogen and in combination in a normal fertilizer analyzing 10 per cent. phosphoric acid, 4 per cent. nitrogen and 3 per cent. potash, somewhat different results were secured in 1926 than had been obtained in previous years. The spring of that year was very dry from the time the fertilizer was applied before planting until after the cotton was about 10 inches high which resulted in severe injury to the young seedlings from the use of large amounts of fertilizer in the drill at planting. This condition was much more marked on plats which had been fertilized with the mixtures containing inorganic sources of nitrogen, as a result the mixtures containing cottonseed meal gave larger returns than did those made from the inorganic nitrogenous materials which had been most profitable in previous years.

A Study of the Effect of Different Proportions of Fertilizer Upon Yield of Cotton. Varying the amounts of phosphoric acid from 6 to 12 per cent. in a complete fertilizer mixture carrying 4 per cent. nitrogen and 3 per cent. potash applied in the drill at planting at the rate of 800 pounds per acre did not materially vary the yields. The four years' average yield from the mixture carrying 6 per cent. phosphoric acid was 1525 pounds as compared with 1504 pounds of seed cotton per acre for the 12 per cent. mixture. However, the high percentage application of phosphoric acid had a marked effect upon hastening maturity. Where 12 per cent. of phosphoric acid was used in the mixture, 50 per cent. of the cotton was open at the first picking on September 24, while where 6 per cent. of phosphoric acid was used only 32 per cent. was open at the first picking. As in the three previous years, varying the amount of potash from 2 to 6 per cent. in a mixture containing 10 per cent. phosphoric acid and 4 per cent nitrogen did not materially affect the yields, although they were increased slightly as the amount of potash was increased. Fertilizer in which the amount of nitrogen was 3, 5, and 7 per cent. in the mixtures showed a reverse from previous years. The highest yields were secured from the lowest application of nitrogen with the yields decreasing as the nitrogen was increased. This was due to the fact that severe injury to the young seedlings during the dry spring resulted from the use of large quantities of nitrate of soda, which was used as the source of nitrogen. This condition was more marked in 1926 than in previous years because of the very dry season from the time the cotton was planted until it was about 12 inches high. From a 10-4-3 mixture applied at the rates of 400, 600, 800, 1000 and 1200 pounds per acre, contrary to the average of the three previous years, the largest yield was secured from an application of 1200 pounds per acre.

RESULTS FROM SOIL TYPE EXPERIMENTS WITH FARMERS

On Norfolk Fine Sandy Loam in Bertie County. The results of experiments for 1926 indicate that for peanuts, a commercial fertilizer mixture

with little or no ammonia is necessary for best returns. Best results were obtained from a fertilizer containing 8 per cent. available phosphoric acid, 4 per cent. potash and no ammonia. Apparently two per cent. of ammonia in mixtures would be the maximum to recommend. Phosphoric acid seems to be the most important constituent with potash coming next.

Gypsum was applied at the rates of 200 and 400 pounds per acre both before planting and on the foliage at blooming time. In every case the use of this material increased the yield. The largest increases were secured by broadcasting it on the foliage at blooming time.

Slight increases were obtained by the use of ground limestone, both when applied before planting and broadcast on the foliage at blooming time. These increases in no case were either as great or as consistent as when gypsum was applied.

On Norfolk Sandy Loam in Wayne County. For cotton, using 800 pounds per acre of mixtures containing 8 per cent. phosphoric acid, 5 per cent. nitrogen and 3 per cent. potash, all applied before planting, the one in which the source of nitrogen was one-half as nitrate of soda and one-half as cottonseed meal gave the highest returns, when compared with mixtures in which all the nitrogen was derived alone from nitrate of soda, from sulphate of ammonia, or from cottonseed meal. The highest yield, however, was secured from the mixture in which the application of nitrogen was derived from nitrate of soda, one-half going on at planting of the crop and the other half reserved and added at time of chopping the crop.

The average yields of seed cotton per acre for three years has been as follows:

Nitrate of soda, ½ at planting and ½ after chopping	1558 lbs.
½ nitrate of soda, ½ cottonseed meal, all before planting	1413 lbs.
Sulphate of ammonia, all before planting	1398 lbs.
Nitrate of soda, all before planting	1378 lbs.
Cottonseed meal, all before planting	1353 lbs.

Varying the amount of phosphoric acid from 6 to 12 per cent. in mixtures containing 5 per cent. nitrogen, and 3 per cent. potash has not materially affected the yields of cotton. The average results have shown slightly larger yields from the lower percentage of phosphoric acid.

Increasing the amount of nitrogen or potash in the mixtures increased the yields, but in every instance where this was done the injury to the young seedlings from the fertilizer was increased with the increase of the constituents. This injury was even more severe when the amount of fertilizer used per acre was increased from 600 to 900 pounds per acre, and decreased when the amount used per acre was reduced to 300 pounds.

On Davidson Clay Loam in Davie County. With wheat in a trial of twenty fertilizer mixtures of varying proportions with the crop of 1926-27 on this type of soil which had been limed during the fall of 1926, it was found that the quantities of the following mixtures, in the order given, afforded larger yields of grain per acre than any of the others:

400 lbs. 10-4-2	26.7 bus.
600 lbs. 12-2-2	24.0 bus.

The use of 400 pounds of a 10-4-2 gave 10.5 bushels more than did 200 pounds of the same mixture per acre, while 200 pounds gave an increase of 6.9 bushels more than where no fertilizer had been applied.

On Iredell Silt Loam in Davie County. Increasing the percentage of potash from 2 per cent. in 600 pounds of a 10-6-2 fertilizer mixture to 4 per cent. potash has led to an increase in the yield of corn of 2.2 bushels, while increasing it from 2 to 6 per cent. in the same mixture gave an increase in yield of corn of 6.9 bushels per acre. "Frenching" of the corn was prevented by the use of 200 pounds of kainit per acre, supplying 4 per cent of potash in 600 pounds of a 10-6-4 mixture, while muriate of potash (both German and Trona), supplying the 4 per cent. of potash in this same mixture did not prove nearly as effective in preventing the occurrence of this trouble. The use of 600 pounds per acre of a mixture containing 10 per cent. available phosphoric acid, 6 per cent. ammonia and 6 per cent. potash in 1924 increased the yield of corn 21.4 bushels over unfertilized corn treated in the same manner.

RESULTS OF SOIL FERTILITY EXPERIMENTS CONDUCTED CO-OPERATIVELY WITH U. S. OFFICE OF SOIL FERTILITY INVESTIGATIONS

On Norfolk Loamy Fine Sand in Currituck County. This experiment was conducted at two places in the county with sweet potatoes. The season of 1926 was extremely dry from the time the plants were set until the potatoes were dug. The stand was decidedly best on the "no fertilizer" plats and those containing no nitrogen. The plats containing high proportions of phosphoric acid in the form of acid phosphate or potash in the form of sulphate of potash had relatively good stands. The plats receiving fertilizer containing as much as six per cent ammonia and higher had poor stands, which was undoubtedly accentuated by the dry season.

The yield of the potatoes was influenced somewhat by the stand. The fertilizer mixture containing 6 per cent. available phosphoric acid, 3 per cent. ammonia and 6 per cent. potash produced the best yield. From the results of this experiment and others in previous years, it appears that a good mixture to use for sweet potatoes grown on this type of soil would be one analyzing either 8-4-6 or 8-4-8.

Sources of Ammonia. In this experiment, the organic ammoniates (cottonseed meal and fish scrap) gave better yields than did the mineral sources of nitrogen, such as nitrate of soda and sulphate of ammonia. Unfavorable results in the latter case appear to be due to the injurious effects which the nitrate of soda and sulphate of ammonia had upon the young potato plants during the extremely dry season which prevailed after the plants were set. These relative yields are contradictory to those secured in previous years, which had more normal seasons, when the inorganic nitrogenous materials gave highest returns. From all facts at hand, it appears safest to use mixtures having their nitrogen derived from two or three different materials, preferably, one-third from nitrate of soda, one-third from sulphate of ammonia, and one-third from organic materials, such as cottonseed meal, fish scrap, or tankage.

Sources of Potash. In a comparison of sulphate of potash, muriate of potash and kainit, sulphate of potash gave largest yields and caused less

injury to the young plants. Quite similar results were secured in the same experiments conducted in 1924 on a similar type of soil. Kainit, in the quantity required to supply the requisite potash in the mixture, was very injurious to the young plants, resulting in a poor stand and low yields.

As a whole, the concentrated fertilizer materials gave just as large yields as did a mixture made up of sulphate of potash, acid phosphate and one-third of the nitrogen each from dried blood, sulphate of ammonia and nitrate of soda.

The mixture made from ammo-phos, urea and sulphate of potash gave the highest yield in the whole field, with the one made up of ammonium phosphate, potassium ammonium phosphate, potassium nitrate and ammonium nitrate coming next. Both mixtures showing larger yields than the commercial mixture given above. The other mixtures studied were below the yields of the commercial goods and came in the following order from the standpoint of yield per acre of sweet potatoes: (1) triple phosphate, urea and potassium sulphate; (2) ammonium phosphate, ammonium chloride and potassium sulphate; (3) ammonium phosphate, ammonium sulphate and potassium sulphate. All the different mixtures applied were equivalent to 1800 pounds per acre of a mixture containing 9 per cent. available phosphoric acid, 6 per cent. ammonia and 6 per cent potash.

On Orangeburg Sandy Loam in Northampton County. Field results have shown that the plant food deficiencies of this type of soil which must be supplied if most profitable results with cotton are to be secured are first, nitrogen; second, phosphoric acid; and third, potash. For cotton in 1926, which was a dry year, the most effective source of nitrogen in 1200 pounds per acre of an 8-6-4 mixture was ⅓ N. from nitrate of soda and ⅔ N. from sulphate of ammonia. The next most efficient sources of nitrogen for crops were nitrate of ammonia alone and a mixture of ¼ nitrate of soda, ¼ sulphate of ammonia and ½ cottonseed meal. As the source of potash, sulphate of potash was slightly better than either muriate of potash or kainit.

Using varying amounts of an 8-6-4 fertilizer mixture from 0, 300, 900 to 1200 pounds per acre profitable increases in yield of seed cotton per acre were secured as follows over the unfertilized portion of the field.

300	pounds	fertilizer _____	600 lbs.
900	pounds	fertilizer _____	771 lbs.
1200	pounds	fertilizer _____	1190 lbs.

On Marlboro Sandy Loam in Wilson County. With cotton, the use of 900 pounds per acre of a 6-6-3 mixture gave the largest yield (1595 pounds) of seed cotton per acre. Other mixtures coming next in yield (each 1566 pounds) were 9-6-0 and 3-6-6.

Sulphate of ammonia as the source of nitrogen in an 8-6-4 for cotton grown on this type of soil produced a higher yield per acre than did either nitrate of soda, nitrate of ammonia, leunasalpeter, chloride of ammonia, urea or phosphate of ammonia.

As a source of potash in the use of 900 pounds per acre of a 7-5-5 mixture for cotton, sulphate of potash produced larger yields than did either muriate of potash or kainit. The most efficient amount of an 8-6-4

mixture was 600 pounds per acre when the quantity was varied by 300-pound increments up to 1500 pounds per acre.

On Davidson Clay in Davidson County. With cotton in trials of 21 different combinations of phosphoric acid, ammonia and potash, the highest yield (1260 pounds) was secured from an application of 800 pounds per acre of a 9-3-3 mixture, this being 570 pounds per acre more than was obtained where no fertilizer was applied. Sulphate of ammonia was a more efficient source of nitrogen this year on this soil than either nitrate of soda, nitrate of ammonia, leunasalpeter, chloride of ammonia, phosphate of ammonia or urea. As sources of potash for cotton, using 800 pounds of a 7-5-4 mixture per acre, muriate of potash was a slightly better yielder than sulphate of potash and decidedly better than kainit.

Using quantities of an 8-4-4 mixture, varying from none up to 1000 pounds per acre, the most profitable quantity this year was 600 pounds per acre for cotton.

TOBACCO BRANCH STATION (Durham Sandy Loam)

The experiments this year with tobacco on this farm, near Oxford, are directly under the charge of E. G. Moss and are being conducted in co-operation with Dr. W. W. Garner of the office of Tobacco Investigations, U. S. Department of Agriculture, under a similar co-operative agreement and plan as that which has been followed in the past. Below are given briefly the size, object, and some of the results secured in each of the experiments.

Regular Fertilizer Experiments. There are in this experiment 36 plats of 1/20 acre each, one-half of each being limed with magnesium limestone at the rate of one ton per acre broadcast every third year.

Object. To test out the more important sources of nitrogen, phosphoric acid, and potash, as well as different combinations and rates of application with and without magnesium limestone.

Result. Cottonseed meal has stood up as one of the best sources, with nitrate of soda coming next in efficiency as carriers of nitrogen in fertilizer for tobacco. Sulphate of ammonia has given good results on the limed end of the plats. A combination of organic and inorganic ammoniates has been found to be better than any of the individual sources. For supplying phosphoric acid, acid phosphate is the best source, basic slag and bone meal being found to be too slow acting for tobacco.

Special Potash Tests. There are ten major plats of 1/20 acre each used in this experiment. The plats are divided into sub-plats of 1/40 acre each which are limed one-half every third year.

Object. To compare the relative values of muriate and high grade sulphate of potash as carriers of potash, using rates of 12, 24, 36 and 80 pounds of potash per acre, the nitrogen and phosphoric acid applications remaining constant.

Results. Muriate of potash has produced a better yield and value per acre than the sulphate; but when the larger quantities of potash are used the burning quality of the cured leaf is not nearly as good from the muriate as from the sulphate plats. There is a constant increase in yield and quality of the tobacco as the potash is increased; therefore it seems advisable to use not less than 40 to 60 pounds of this constituent per acre,

not more than 20 pounds of which shall be derived from muriate of potash. By the use of small amounts of muriate up to about 20 pounds of potash per acre, there does not seem to be enough chlorine present in the cured leaves of the tobacco to injure their burning qualities.

Different Sources of Potash with Dolomite and Calcite. In this experiment there are eighteen 1/40 acre plats.

Object. To compare the chief available sources of potash, viz: Trona muriate, German muriate, alunite sulphate, German sulphate, magnesium-potassium sulphate, and kainit. These plats are divided into three series: first, on which dolomite (magnesium limestone) is used; second, on which calcite (lime with less than 1 per cent magnesia) is used; and third, on which no lime is applied.

Results. The section on which magnesium limestone has been applied has given best yield and quality with no occurrence of "sand-drown". On the other two series "sand-drown" has occurred on all plats, except where sulphate of potash-magnesia was applied. The kainit plats have given a large yield of tobacco but the quality of leaf was poor.

Quantitative Magnesium Tests. This test was started in 1923 and includes eleven plats of 1/20 acre each.

Object. To determine the actual amount of magnesia required for tobacco under normal conditions to prevent "sand-drown" or magnesia hunger from occurring.

Results. It has developed from these experiements that comparatively small amounts of available magnesia present in the soil will prevent "sand-drown". The magnesia can be supplied either from magnesium limestones or from potash salts carrying considerable of this constituent such as sulphate of potash-magnesia.

Special Magnesium Tests with Magnesia, Sulphur and Chlorine for Tobacco. This test was started in 1923 with twelve plats of 1/40 acre each.

Object. To determine the effects which magnesia, sulphur, and chlorine each has upon tobacco and the relative value of each for this crop.

Results. These tests have not yet been running a sufficient length of time to arrive at any definite conclusions with reference to the value of each of these.

New Nitrogen Tests. These tests were started in 1925 with forty-three 1/20 acre plats, subdivided into 86 of 1/40 acre in size, one-half of all being limed.

Object. To test out new sources of nitrogen for tobacco, especially those that have some possibility of being put on the market in such quantities and at such prices as to make them a factor as sources of nitrogen in fertilizers in crop production.

Results. At present no definite conclusions have been reached, but there are several sources that show promise, principally among which are urea and leunasalpeter of the synthetic products and ground fish of the organics.

Experiment with Tobacco After Cowpeas. This experiment covers one-half acre and is divided into four plats of ⅛ acre each.

Object. To determine if tobacco can be grown after cowpeas, provided sufficient amounts of phosphoric acid and potash are supplied to meet the needs of the crop.

Results. It has developed that tobacco of fair quality and yield may be grown on land after cowpeas or soybeans have been plowed under, provided liberal applications of phosphoric acid and potash are added, and the tobacco is planted reasonably close in the drill, topped high and harvested by priming.

Rotation System for Tobacco. There are four plats of ½ acre each in this experiment.

Object. To test out a few practical systems of rotation with tobacco as the principal money crop as follows:

(1) A four-year rotation with corn, oats, grasses and tobacco.
(2) A three-year rotation with oats and rye and tobacco.
(3) A two-year rotation with rye and tobacco.

Variety Test. In this test, there are 25 plats of 1/20 acre each.

Object. To test out and classify the various so-called varieties of tobacco and to select those best suited for the production of cigarette tobaccos.

Results. During the past few years, something over 150 varieties of tobacco have been tested, these frequently showing differences in value between the poorest and the best of $75.00 to $100.00 per acre. Three or four of the varieties which have given the best results, have been advocated and seed of them have been distributed to leading growers.

Plant Nutrition Investigations. In these investigations, fields I, II, III and IV with 1/40 acre plats are being used.

Object. To test in Fields I and II the crop effect on six major crops, viz: wheat, oats, rye on tobacco, corn and cotton and vice-versa. On Fields III and IV, the effect of different legumes, viz: vetch, clover, soybeans, cowpeas and grass on tobacco, cotton and corn and the residual effect on wheat, oats and rye.

Results. These are most interesting experiments and have shown that cotton and corn give excellent results after all the legumes, but make larger yields after vetch and clover than they do aften soybeans and cowpeas. On the other hand, tobacco has done best after fallow and grasses than after any of the legumes.

Additional Experiments with Sulphur, Chlorine and Magnesia. In these experiments, forty-two additional 1/20 acre plats were started in 1926.

Object. To determine the effect each of sulphur, chlorine, calcium and magnesia upon the growth, yield and quality of tobacco and to work out their relation to the use of different forms of potash.

Results. As 1926 was the first year in which this experiment was conducted, no definite results as yet have been obtained. Indications are, however, that a very small amount of chlorine is desirable for tobacco. The use of too much in the fertilizer mixture, however, will undoubtedly injure the burning quality of the cured leaves.

Distance of Tobacco Planting Experiments. There are 16 plats of 1/20 acre each in this experiment. The rows are four feet apart and the tobacco was planted 18, 24, 30 and 36 inches in the row, with different rates of fertilization for each series of four plats.

Object. To determine the distance plants should be set with different rates of fertilization, considering yield and quality of tobacco produced.

Results. Tobacco transplanted 18 inches apart in the row has given better yields per acre and quality of crop than did those which had more distance between plants. In 1926, the tobacco was transplanted after the

soybeans were plowed under, using 1000 pounds of an 8-3-3 fertilizer mixture per acre. When transplanted 12 inches in the row, which required a little over 10,000 plants to the acre, the quality and yield of the tobacco were good.

SOME RESULTS OF SOIL FERTILITY EXPERIMENTS

On Norfolk Sandy Loam. As an average of 12 years' experiments at the Edgecombe farm, the following results were secured in the yield of seed cotton per acre:

Complete fertilizer (NPK)	907 lbs.
Unfertilized (O)	258 lbs.
Difference	649 lbs.

The cost of the yield per pound of seed cotton in the above was as follows:

Complete fertilizer (NPK)	5.25 cts.
Unfertilized (O)	13.80 cts.

On Cecil Clay Loam. As an average of 13 years' experiments at the Iredell farm, the following results were secured in the yield of seed cotton per acre:

Complete fertilizer (NPK)	925 lbs.
Unfertilized (O)	171 lbs.
Difference	754 lbs.

The cost of the yield per pound of seed cotton in the above was as follows:

Complete fertilizer (NPK)	5.18 cts.
Unfertilized (O)	20.81 cts.

Note—Cost of producing an acre of cotton, not including the cost of fertilizer is taken at $35.59.

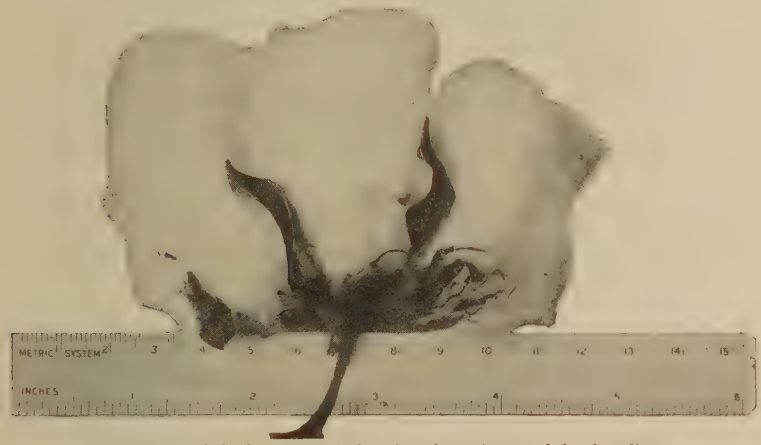
III. CROP IMPROVEMENT AND CULTURAL WORK WITH COTTON, SOYBEANS AND FORAGE CROPS

Inheritance of the Fuzzy Tip Character in Cotton Seed. Several strains bearing seed which have a fuzzy tip similar to the Sea Island and Egyptian types of cotton have been isolated from the Cleveland variety. One of these strains (No. 138) appeared to be homozygous for the fuzzy tip character in 1925. This strain was crossed with pure fuzzy and fuzzless strains in 1926. In the fall of 1926, this strain (No. 138) was found to be segregating. The F_1 plants from these crosses are being grown in 1927 as well as are the fuzzy tip parents of these crosses. These strains are being purified and as soon as a homozygous strain can be isolated crosses will again be made.

The results thus far secured indicate that the fuzzy tip is a pattern character, and is produced by a separate pair or pairs of characters from those which produce naked and fuzzy seed. It is very evident that this character is not an intermediate stage between the fuzzy and naked condition.

Cotton Breeding. Cotton improvement work is being conducted at the Central, and at the Piedmont and Upper Coastal Plain Branch Station

farms. Pedigreed strains of the Mexican Big Boll variety have been grown on these farms for several years. Further improvement is being made with these strains. Plant-to-row selections, strain comparisons, and increase plats are grown each year. The characters considered are earliness, uniformity of the plant, size of boll, yield per acre, uniformity of lint, and spinning quality. The object being to develop a high yielding strain of cotton of good spinning quality that will meet the requirements



Showing a boll from cotton that has been improved by breeding.

of the mills of the State for a cotton of an inch to an inch and one-sixteenth staple. In a large number of variety tests, these strains have produced a greater money value per acre than have any other cottons having the same or a shorter staple. In spinning tests, these strains have been found to be equal, and in some cases superior, to cottons of the same staple grown in the Delta region and other areas which are supposed to produce cotton of an unusually high spinning quality.

Heavy vs. Light Seed for Planting. An experiment was begun in the spring of 1927 to determine the value of planting heavy cotton seed. Individual seed were carefully weighed out, the weights varying from .05 to .20 gram. Three classes of seed were selected for planting as follows:

Class A—weighing 0.15 to 0.16 of a gram each
Class B—weighing 0.12 to 0.13 of a gram each
Class C—weighing 0.08 to 0.10 of a gram each

The medium weight (Class B) germinated almost as well as did the heavy seed (Class A), the plants appearing vigorous and growing off well. The light weight seed (Class C) gave a 40 per cent lower germination than did the heavy seed, the seedlings lacked vitality and 45 per cent more of the seedlings died than did those grown from the heavy seed. Plants grown from light seed were much smaller on June 30 than those grown from heavy seed. Data on fruiting, earliness and yield will be secured during the coming fall.

A comparison of the viability and vigor of seed grown under favorable and unfavorable conditions was begun in 1927. The same pedigreed

strain of Mexican Big Boll was grown at Fayetteville and at Oxford in 1926. Conditions were nearly normal at Fayetteville, while at Oxford during the latter part of August and all of September and October the weather was very dry. The cotton caterpillar stripped all the leaves off the plants at about the time the first bolls began to open. Composite samples taken from the seed grown at the two places showed the seed grown at Fayetteville were 49.2 per cent. heavier than those grown at Oxford. The seed from Oxford gave 25 per cent. less germination and 20 per cent. more plants died than from the Fayetteville grown seed. The plants grown from Oxford seed were considerably smaller than from the Fayetteville seed.

Several varieties of inch to inch and one-sixteenth cotton are being compared under similar conditions. These tests are being conducted on three soil types. Data will be secured on earliness, size of boll, yield, staple, percentage of lint, uniformity of lint, strength of lint, and spinning quality.

Methods of Treating Cotton Seed. An experiment to determine the value of different methods of treating cotton seed is being conducted in cooperation with the Plant Disease Department of the Station. The methods of treatment are: (1) delinted with sulphuric acid; (2) delinted by machinery; and (3) dry heated. Untreated seed were used as a check. The acid delinted seed gave a quicker germination than did the other treatments or the check lot. Machine delinted seed were next in earliness, and heat treated seed and the checks were about the same. Acid delinting appeared to make the seed more liable to rot in the ground during a cold wet spell, especially when the seed were planted early.

The greatest advantage is secured from delinting the seed when the planting date is medium to late. Good stands have been secured from delinted seed when the soil was so dry that undelinted seed would not germinate. Planting to a stand with acid delinted seed with corn and peanut planters was found to be very satisfactory, about one peck of seed being planted per acre. Delinting with acid and the heat treatment reduced the amount of disease carried by the seed, the heat treated plats showing slightly less disease on the seedlings than the acid delinted plats.

Date of Planting Cotton. During the past four years, plantings have been made at the Upper Coastal Plain Branch Station on the following dates: April 10, April 20, April 30 and May 10. The April 30 plantings have given slightly higher yields than did either those made on April 20 or May 10, and also gave considerably higher yields than did those made on April 10. The lower yields from the April 10 and April 20 plantings were due to poor stands, as they were better fruited and earlier than the later plantings. While the May 10 plantings have yielded fairly well, they suffered severe damage during a year favorable to boll-weevil infestation.

Cotton Spacing. Results of spacing experiments on the Coastal Plain, Piedmont and Coastal Branch Station farms show that the cotton plants can readily adapt themselves to a wide range of conditions. The spacings of 8 to 24 inches with 1, 2, and 3 plants per hill have not shown great differences in yield per acre. The closer spacings, 8 to 10 inches on the poor soils and 10 to 12 inches on the more fertile soils, with an average of two

plants to the hill, have given slightly larger yields over a period of years than have the wider spacings of the plants in the row. The closer spacings also fruit earlier. For maximum yields, it is very important that the plants be evenly distributed, fifteen to twenty thousand plants per acre uniformly distributed is the general recommendation of the Department.

Soybean Improvement. Variety tests have been conducted on all the station farms. The varieties grown in the State and promising new varieties were included in these tests. The leading varieties have been found to be for the eastern part of the State, Tokyo, Herman and Mammoth Yellow for seed; Laredo, Otootan and Mammoth Yellow for hay. For the upper Piedmont and Mountain section: Herman, Midwest and Virginia for seed; and Laredo, Virginia and Herman for hay.

Forty new importations are also being tried out this year and selection work is being carried on with several varieties. Larger yields of hay and seed and more uniformity has already been secured.

Selection work for high oil content has been discontinued because it was found that larger yields of oil per acre could be secured by selecting for higher total yields per acre than for higher oil content. A high per cent. of oil was found to be associated with low protein and vice versa. No correlation was found between the per cent. of oil in the seed of individual plants and in their progeny. None of the strains were consistently high or low in per cent. of oil during the seven years they were grown, the yield of seed from the different strains showing much more variation than did the per cent of oil present in the seed.

Mottling of soybeans may result from several causes, such as inheritance, hybrizing, soil, climate, and physiological conditions. Certain pedigreed strains were found to mottle worse than other strains of the same variety. Plants having mottled seed will in some cases segregate. Certain varieties and pedigreed strains were relatively free from mottling when grown at the Central farm, but mottled badly when grown at the Mountain farm, the difference evidently being due to either differences in soil or climate, or both. One or more branches on plants were found to produce only mottled seed, while the remainder of the plants produced normal seed, this was evidently due to abnormal physiological conditions, perhaps caused by an injury to these parts.

The time of blooming and ripening was found to be affected by the location in which the seed were grown. Soybean seed grown at Raleigh were compared with the same pedigreed strain which had been grown at Swannanoa for one or more years. The comparison was made on both the Central farm at Raleigh and the Mountain Branch Stations at Swannanoa. In both cases, plants grown from seed produced at Raleigh bloomed and ripened five to ten days later than did plants produced by seed grown at Swannanoa. The elevation of Raleigh is 390 feet, while that of Swannanoa is 2250 feet, the latitude being approximately the same.

Vetches. Different varieties of vetch and seed of hairy vetch from different sources were compared. Hairy vetch seed from Central Europe, East Prussia, Michigan and Oregon showed very little differences in growth and earliness. Woolly podded and Monantha vetches made an early spring growth but did not make as heavy growth as did the hairy, common

and purple vetches. Purple vetch winter-killed very little during the winter of 1926-1927, but had winter-killed 80 to 95 per cent. during the three previous years.

Small Grains for Winter Cover Crops and Spring Hay Crops. Abruzzi rye has been found to produce more green material and was ready to turn under earlier than any other small grain seeded at the same date. Rosen rye was found to make only about one-half as much growth as Abruzzi rye. It was also inferior to wheat, oats and barley. Early seedings of small grain were found to make a much heavier growth in time to turn under for another crop than did later seedings. The yields of hay were also much heavier from the earlier seedings. Oats and a barley-oat-wheat mixture made larger yields of hay than did either wheat or barley sown alone.

EXPERIMENTS WITH VARIETIES OF SMALL GRAINS

At Piedmont Branch Station. The purpose of this experiment as conducted has been to lay the foundation for future work in grain improvement in the State. At this farm, there has been conducted a variety and strain test for five consecutive seasons with leading varieties of small grain usually grown in Piedmont North Carolina. Five of the leading varieties of wheat grown in this section of the State were tested for comparative yields during this period with the following results:

Varieties	Average Yield (Bus.) per Acre
Fulcaster	28.7
Purple Straw	27.9
Gleason	27.5
Stoner	27.4
Leaps' Prolific	26.2

These average results determine the relative rating of these leading varieties of wheat for yield. The leading varieties in this test are to be continued in future tests as standards by which to compare new varieties or strains that might appear desirable to introduce into the State. For example during the last three years of this test Alabama Blue Stem and Pennsylvania No. 44 were introduced into the test. In the average yields for the three remaining years both these outyielded all the other varieties in the test. The first is an improved variety selected by the Alabama Station and the second is an improved strain of Fulcaster selected by the Pennsylvania Station.

The test of common and Abruzzi ryes for the same period showed a difference in average yields of 4.6 bushels per acre in favor of the Abruzzi variety. This result further confirms the fact that Abruzzi rye is especially adapted to that part of North Carolina lying east of the Blue Ridge.

Three strains of hooded barley were compared with each other and with the oats and rye in the same test. One of them was a local strain and the other two were improved strains secured from the Tennessee Station. The strain of North Carolina origin outyielded the leading Tennessee strain by only 0.6 bushel. There was a difference of 4.9 bushels per acre in yield between the two Tennessee strains, No. 6 being the higher yielder. Fall-sown Fulghum oats outyielded the Appler variety by 1.6 bushels per acre. Both proved low in cold resistance, being killed outright in the

winter of 1923-1924 and only about 5 per cent. of each survived the winter of 1926-1927. Lee (a selection from Culberson) proved far more cold resistant than did either of the other two.

One of the interesting results of this test is found in a comparison of the relative yields of the different leading grains compared in the tests. On account of the difference in weight of a measured bushel of the different grains, the comparison of yields are reported in pounds per plats, which were as follows:

Grains	Average Yields (Lbs.) per Plat
Rye (Abruzzi)	90.6
Wheat (Fulcaster)	83.6
Barley (Tennessee No. 6)	72.0
Oats (Fulghum)	46.0

In order that the yields may be recorded in actual pounds of grain production, 30 per cent. was deducted from the original weight of oats for husks, and of 15 per cent. from barley.

At Mountain Branch Station. The same five leading varieties of wheat were tested for the same period as at the Piedmont Branch Station. The average yields have changed the rating somewhat of some of the different varieties from what they were at the Piedmont farm. For example, Leaps' Prolific which ranked fifth at the Piedmont farm ranked second at the Mountain farm. This indicates that perhaps some of these varieties are better adapted to mountain condition than to those obtaining in the Piedmont section of the State. On the Mountain Branch Station the varieties ranked as follows, given in the order of their rank in yield of grain per acre: Fulcaster, Leaps' Prolific, Purple Straw, Stoner and Gleason.

Common and Abruzzi varieties of rye were also tested and it was found that the Abruzzi outyielded the common by only 0.2 bushel per acre.

It is well known that clayey upland soils are better adapted to wheat-growing than are sandy bottom-lands that usually contain more vegetable matter. There is a popular notion among farmers that a bearded variety of wheat will outyield a smooth wheat on bottom-land or any other land not well adapted to wheat. To prove or disprove this popular notion, in addition to the plats seeded on the upland in the test at the Mountain farm, a plat each of Fulcaster and of Leaps' Prolific was seeded on typical bottom-land. The Fulcaster outyielded in both cases. It yielded on the upland at the rate of 23.5 bushels per acre, on the bottomland at the rate of 20.8 bushels, a difference of 2.7 bushels per acre in favor of the upland. Leaps' Prolific yielded on the upland 22.6 bushels per acre, and on bottom-land only 16.1 bushels, a difference of 6.5 bushels in favor of the upland. The Fulcaster on the upland outyielded the Leaps' Prolific only 0.9 bushel per acre; on the bottom-land 4.7 bushels. Fulcaster is a bearded rust-resistant variety, while Leaps' Prolific is a smooth rust-susceptible variety. Based on these data, upland appears better adapted to wheat-growing than bottom land. Bearded varieties, at least rust resistant varieties, appear better adapted to bottom-lands than is the smooth headed, or rust susceptible variety.

Improvement Work with Corn. Systematic field selections of seed corn has been continued on all the six branch station farms for more than five years. Results were secured for the first time on three of the farms by a variety

corn test. The strain developed on the Mountain Branch Station farm has ranked in yield only sixth in a competitive test with eight other leading varieties for that section. The strain developed on the Piedmont farm has ranked first in a test of ten varieties. In a test of nine varieties at the Central farm the strain developed has ranked fourth. The strains on the other farms have not yet been tested. One test does not determine the rank of these strains but does indicate their probable rank and the progress which is being made.

PHYSICAL PROPERTIES OF COTTON FIBERS AND THEIR RELATION TO THE SPINNING QUALITY AND COTTON IMPROVEMENT

Certain physical properties of the cotton fiber known to the trade as "drag", body, character, etc., are considered associated with spinning quality. The properties known by the above terms are no doubt complex in their nature and do not lend themselves readily to accurate measurement. It is important that they be analyzed more carefully, measured more accurately and evaluated for spinning purposes. Such studies should yield more definite information for the cotton breeder and make it possible to better judge his selections.

A METHOD FOR MEASURING "DRAG" IN LINT COTTON

"Drag" is the friction encountered when adjacent fibers are pulled apart. Several trials were made to measure drag by measuring the resistance of fibers when drawn through a fine wire brush, similar to those used on the carding machines. Due to the variation in inserting the sample and differences in size of sample this method failed to give constant results. Samples were then drawn apart by the use of fine and coarse combs and efforts made to show a relation between the weight of fibers drawn through the combs and the measured force required to draw them through. The results of these tests were not constant due in part to differences in preparation of samples and compression. In comparing samples of cotton for "drag" it is necessary to arrange the fibers of each sample in similar positions. Carding brushes were constructed and they are used to arrange the fibers of various samples in similar positions. A pair of brushes is used for the carding process. Each brush is made by tacking card clothing (used on carding machines) on one end of a light piece of wood which is 14" x 1¾" x ¼". The card clothing used on each brush is 6" x 1'. Just enough tacks are used to hold the card clothing in place. It was found that the carding could not be done when the card clothing was too rigidly attached to the wood supports or backs.

In this method, for each determination, a two-gram sample of clean lint cotton is weighed and then carded into a sliver. Each sliver is then reweighed and clamped in a wooden cylinder having an inside diameter of one inch and a length of four and one-half inches. The slivers are tied at the ends of this cylinder with thread. A longer thread is then tied near the ends of each sliver. The force necessary to pull each sliver in two parts is measured on a single strand yarn testing machine. In making all determinations, the samples of cotton are weighed, carded, and pulled apart under the same conditions of temperature and humidity. In order to take care of slight variations in weight when comparing

samples of different cottons the "drag" is computed on "per gram of card sliver" basis. The total weight of card sliver tested for "drag" is divided into the total force recorded, and thus a fair basis for comparison is derived. Some results of tests for "drag" by this method are given below.

Tests of Cotton from Crop of 1926. A representative sample of seed cotton was available from the Mexican and Acala varieties of cotton. This cotton was ginned on a small roller gin and under the same conditions. The amount of lint cotton available from each variety was limited and only fourteen determinations could be made on each sample. Data obtained are as follows:

Card Clothing Used 1½" x 6"

	Grade	Length of Staple Inches	"Drag" per Gram of Card Sliver in Grams	Relative "Drag" in Percentage Ratio Basis
Mexican No. 6 (Oxford)	S.M.	1 1/16	136	100
Mexican No. 6 (Fayetteville)	S.M.	1 1/16	146	107
Acala No. 8 (Fayetteville)	S.M.	1 1/16 full	180	132
Acala No. 5 (Oxford)	S.M.	1 1/16	194	141

Results secured indicated that the method was promising and the department decided to find two bales of cotton showing contrast in "drag" and carry out a spinning test on them. It was thought that a spinning test would give an opportunity for testing the reliability of the method and at the same time the relation of "drag" to the manufactured yarns and spinning could be studied. In order to isolate the desired bales, "drag" tests were made on thirteen bales belonging to the N. C. Cotton Growers' Co-operative Association. Five determinations were made on each bale. Data obtained are as follows:

Card Clothing on Brushes 1½" x 6"

Warehouse No. of Bale	Grade*	Staple in Inches*	"Drag" per Gram of Card Sliver in Grams	Relative "Drag" Percentage Ratio Basis
134,043	G.M. spotted	1	110	100
133,775	S.M. spotted	1	113	103
379,530	S.M. spotted	1	121	110
176,107	S.M. stained	1 1/16	123	112
175,970	G.M. spotted	1 1/16	132	120
175,969	G.M. spotted	1 1/16	141	130
176,096	G.M. spotted	1 1/16 full	147	134
176,221	S.M. spotted	1 1/16	159	145
377,749	S.M. spotted	1 1/16	163	148
176,036	S.M.	1 3/16	166	151
176,038	S.M.	1 3/16	169	154
176,076	S.M.	1 3/16	203	185
176,733	S.M.	1 1/16 full	214	195

* Grade and staple are listed here as given by N. C. Cotton Growers' Co-operative Association.

The results in the above table show that there is considerable difference in the drag of different bales of cotton even when the staple length is the same.

It was found that bales No. 176,733 and 176,096 were approximately the same length. Preliminary "drag" tests showed about 50 per cent. difference. These two bales were used for the spinning test.

The data on final "drag" tests from twenty determinations are as follows:

Hand-Carded Cotton (Card Clothing 1' x 6")

Bale No. and Variety	Grade*	Staple in Inches*	Drag per Gram of Card Sliver	Relative "Drag" Percentage Ratio Basis
176,733 Acala	G.M.	1 5/32	127	144.3
176,096 Mexican	G.M. light spotted	1 4/32	88	100.0

*Grade and staple determinations were made by Division of Cotton Marketing of the U. S. Department of Agriculture.

During the spinning of the two bales, samples were saved from all stages in the process of manufacture, and twenty determinations have been made for "drag" on the sliver and roving on them as they came from the different machines.

Machine Carded Cotton

Bale No. and Variety	"Drag" per Gram of Card Sliver	Relative "Drag" Percentage Ratio Basis
176,733 Acala	218	135
176,096 Mexican	162	100

Drawing Frame—Second Drawing

176,733 Acala	49.4	128
176,096 Mexican	38.6	100

The results of "drag" tests made on stock from the cards and drawing frames show that one of the bales has considerably more "drag" than the other and therefore it is believed that the relative "drag" can be determined by the use of hand-carding brushes.

The future value of the method described will depend largely upon the spinning value of "drag" itself. The method should be of considerable research value in that it will enable the investigator to measure "drag" and determine its value in cotton spinning.

**A Study of Yarns Spun from North Carolina Cottons.* Through the co-operation of the Office of Cotton Marketing, spinning tests have been conducted with cotton saved from three improved varieties and one unimproved variety. The tests consisted of comparisons of varieties grown under the same conditions and of certain varieties grown in different

*Done in co-operation with the Office of Cotton Marketing, Bureau of Economics of the U. S. Department of Agriculture.

sections of the State. The yarns had previously shown differences in breaking strength. Data taken on the raw material indicated that some of the differences in strength of yarn were due to differences in length of staple but there remained others in which length of staple could not account for differences in strength of yarn. These were examined to find other explanations for the differences. For this purpose twelve-inch samples were cut from the yarns at intervals of six feet. The samples were weighed individually and cross-section fiber counts made from each sample to determine the relation of number of fibers per cross section to strength. This factor was so variable that no conclusions could be drawn. The irregularity of size within the same yarn and between yarns of different varieties introduced a factor which had a greater influence than the number of fibers in the cross-section. As a result of this study it appears that the differences in size of yarn studied has been largely responsible for the differences in strength noted when varieties of the same length were being compared. Before yarn structure can be carefully studied in relation to strength, it will be necessary to more accurately control sizing or examine a much larger number of samples than were possible in this study.

SPECIAL FERTILIZER INFORMATION SERVICE FOR FARMERS

Hundreds and hundreds of letters come to the Department yearly from farmers for information with reference to the most suitable sources of nitrogen, potash, phosphoric acid and lime; best proportioning of these fertilizer constituents; and the most economical quantities of mixtures recommended for them to use per acre for the different crops which they are growing on their different types of soil which are in varying conditions of improvement. Many of these inquiries are accompanied by samples of soil, drawn in accordance with instructions prepared and supplied by the department, from their fields for which they wish definite information with reference to their best fertilizer treatment. In each individual case, after the type of soil and its physical condition has been established and its acidity has been determined in the laboratory, recommendations are furnished for each crop it is wished to fertilize, based upon knowledge from the average findings of carefully conducted soil-type field experiments for the particular type or types of soil each farmer has on his farm and for which he wishes information. It is felt that this plan is the only safe and logical one to follow in formulating and making recommendations.

It is believed, too, that this definite service, which is being used by a markedly increased number of farmers of the State each succeeding year has been an important factor in aiding them in the use of fertilizers.

C. B. WILLIAMS, Head, Department of Agronomy.

ANIMAL HUSBANDRY RESEARCH

The following is a progress report of the Quality of Meat Study inaugurated in 1925 on Purnell funds. The project was outlined with the idea of conducting from three to five years' work, depending upon the progress made. Only two years' work has been conducted, however so at best only a progress statement can be made.

In some respects the differences which developed in the two series, one of which was fed an all corn concentrate and the other an all cottonseed meal concentrate, were rather clear cut. It would be necessary, however, especially in drawing out the finer distinctions of quality, to continue the work longer.

The progress statement follows.

*QUALITY OF MEAT STUDY

This project entailed a determination of the influence of sex and of cottonseed meal versus corn on the quality of meat. It is for the purpose of specifically determining whether sex affects the quality of meat in any way, and further, to make a study of the quality of meat as produced in one case from corn alone as a concentrate and in the other from cottonseed meal alone as a concentrate.

Work has been conducted on this project for two years, that of the second year being a replication of the first except that the second year steers and heifers of a more comparable quality were used. During each of the two years the cattle were fed in the following manner after having followed out the standard practice in experimentation with animal groups.

The basic rations were as follows:

Cracked corn Cottonseed hulls Alfalfa hay Wheat straw	Fed to one group of steers and one group of heifers
Cottonseed meal Cottonseed hulls Alfalfa hay Wheat straw	Fed to one group of steers and one group of heifers

* Conducted in co-operation with the Bureau of Animal Industry, U. S. Department of Agriculture.

Table Showing Weights and Gains—1925-26

Ration	Lot I Steers C.S. Meal C.S. Hulls Alfalfa Hay Wheat Straw	Lot II Steers Cracked Corn C.S. Hulls Alfalfa Hay Wheat Straw	Lot III Heifers C.S. Meal C.S. Hulls Alfalfa Hay Wheat Straw	Lot IV Heifers Cracked Corn C.S. Hulls Alfalfa Hay Wheat Straw
Aver. in. wt. in lbs.	866	838.5	623	647
Aver. final wt. in lbs.	991.5	1005.0	736.6	766
Aver. total gain per animal in lbs.	125.3	166.4	113.3	119
Aver. daily gain per animal in lbs.	1.44	1.91	1.53	1.37
Average dressed wt.	533.5	593.5	348.9	352.0
Aver. dressing percentage	55.9	59.1	48.7	49.3
Average Daily Feed per Animal in Pounds				
Cottonseed Meal	7.0		6.3	
Cracked Corn		14.4		11.4
Cottonseed Hulls	5.7	5.6	5.6	5.6
Alfalfa Hay	4.6	5.0	5.0	5.3
Wheat Straw	10.0	10.0	10.0	9.5
Average Amount of Feed Used Per Pound Gain				
Cottonseed Meal	4.89		4.88	
Cracked Corn		7.54		8.36
Cottonseed Hulls	3.98	3.00	4.41	4.09
Alfalfa Hay	3.20	2.61	3.83	3.89
Wheat Straw	6.93	5.22	7.67	7.13
Cost Per 100 Pounds Gain				
	$21.35	$25.0e	$23.19	$30.92

STATEMENT OF PROGRESS

1. This work has shown that cottonseed meal can be used safely as a sole concentrate for finishing beef cattle over a period of approximately five months even when closely confined in barns. There were no indications of any harmful effects whatsoever, in this respect ranking favorably with the cattle fed the corn ration.
2. It was rather clearly brought out that the carcasses from the cottonseed meal fed cattle were, when cut, somewhat darker in color than those from the cattle fed corn. There is so far, no indication whatever that this factor deters from the quality of meat.
3. The cattle fed the corn rations made somewhat larger daily gains although the difference was not great. It required, however, approximately twice the amount of corn as of cottonseed meal per steer daily to make the extra gains. This was especially true during the last year of the work. The difference was not as great the first year.
4. The cost per 100 pounds gain was considerably greater each year in the corn fed lots than those fed cottonseed meal. This was par-

ticularly true the first year although it occurred to a marked extent during the second year of the work.

5. The average grade of the cattle in each of the four lots at the beginning was practically the same, all factors being made as nearly equal in each lot as possible. As slaughter cattle those fed corn graded approximately three to five per cent. higher than those fed cottonseed meal, this applying to the steers and heifers respectively during the last year of the work. As carcass cattle the average grading was approximately 5 per cent. higher for the steers and heifers fed corn over those fed cottonseed meal.
6. The higher grading of the slaughter and carcass cattle from the corn fed lots over those from the cottonseed meal fed lots of cattle would indicate a somewhat better quality naturally owing to the greater accumulation and distribution of fat in the carcasses. This would not be conclusive evidence, however, in any case since the cottonseed meal fed cattle had not attained the same degree of finish.

COTTONSEED MEAL INVESTIGATIONS

Project No. 1. The specific purpose of this project was to determine the effect of a cottonseed meal and corn ration when fed in various quantities to different individuals on reproduction and lactation. The roughage part of the ration was made up of one-third cottonseed hulls and the remaining portion of roughages of good quality. A mineral mixture was fed in addition to all the cows in the four groups consisting of two animals each or eight in all.

Group No. 1 received a ration consisting of fifty parts cottonseed meal, and Group No. 4 a ration consisting of one hundred parts cottonseed meal. Groups 2 and 3 receiving intermediate amounts of the same concentrate in their ration.

During the last year all of the cows in this project have produced normal living calves except one receiving large quantities of cottonseed meal. This cow was gaunt and badly swollen last year and of necessity taken out of the experiment. She is otherwise normal this year but not in calf.

With the exception of this latter animal all individuals in the group have been fed their regular rations without any reduction in quantity at any time during the past two years during this time consuming relatively large amounts of cottonseed meal.

Project No. 2. The object of this project was to determine the effect of deficiencies of meals prepared from high oil bearing seeds on the health and reproduction of calves.

During the past year there was some change in procedure. All supplements were omitted except the mineral mixture and iron oxide. Wheat straw was omitted from the ration, beet pulp and cottonseed hulls being substituted.

Previous to these changes the group fed linseed meal did not react in the same manner to the ration received as did the other groups. The linseed meal group was more thrifty. With the above changes instituted all groups reacted in a similar manner. These reactions in some cases were so severe that the animals did not survive, particularly after calving.

Twelve animals divided into four groups of three each were used of

which one-half survived, two of these being fed cottonseed meal, two linseed meal and two peanut meal. None have survived on the soybean meal ration.

In order to prevent any more deaths cod liver oil was given to all surviving animals. This has somewhat alleviated the deficiency symptoms of partial blindness, running eyes and unthriftiness. Discontinuance of the oil has brought them on again in a rather severe form in the groups fed linseed meal and peanut meal.

It is also being ascertained whether the calves born from the heifers in these groups and being fed on the mother's milk were also suffering from Vitamin A deficiency. Livers from five of these heifers and four calves are being examined to determine the Vitamin A content.

Project No. 3. The purpose of this project was to study the effect on growth, reproduction and lactation of dairy heifers when fed an exclusive ration of cottonseed meal in combination with mineral matter and varying quantities of cottonseed hulls and timothy hay in the roughage part of the ration. Six heifers were used, these being divided into three groups of two each, none of which have died from the effects of feeding heavy rations of cottonseed meal.

The heifers which have received the timothy hay and cottonseed hulls for roughage throughout the experiment have been bred repeatedly but up to date have not conceived, while those which have been fed alfalfa hay are all in calf. The differentiation in this respect is quite clear as all of the animals in this group are free from infectious abortion and the difference in results therefore quite clear and striking.

The results are comparable to last year, those receiving the poorest quality of roughage failing to respond as did those where alfalfa hay was used.

Project No. 5. During the progress of our main cottonseed meal investigations there were indications which were more specific at times indicating to some extent that the harmful effects of cottonseed meal were transmitted through the mothers fed heavily on cottonseed meal to the progeny. This particular project was outlined and conducted to make more definite determinations than were possible during the regular routine of the main experiment.

The calves were allowed to suckle the dams in order that any source of contamination through unsanitary milk pails would be completely eliminated. The specific lead obtained, the method of prosecuting the work and the results follow.

EFFECT OF MILK ON CALVES

During the progress of the cottonseed meal investigations which have been under way here for a number of years various suggestions and leads have been obtained through the work conducted on the main project involved. One of these which was not only unusually interesting but indicated to some extent that economic factors might be involved was an indication that a cow which had dropped twin calves and which had previously been fed a very heavy ration of cottonseed meal was transmitting the harmful effects of cottonseed meal through the milk to the calves.

The chief reason for this assumption was that the calves ultimately became almost totally blind before the close of the milk stage of feeding. Whether this had developed during the foetal period and was gradually growing worse or was an outgrowth of a premonitory condition which developed at the beginning of the lactation period became a question which seemed well worth while to answer. Much of the milk produced, and especially at that time, was from cows fed quite heavy rations of cottonseed meal, some even receiving rations made up exclusively of cottonseed meal and hulls.

It thus became a question involving not only the growth and development of animals but of the human race and in order that something definite might be obtained on the subject the following project was outlined and conducted during the past year. In order that every possible error might be eliminated the work was planned on a basis of the calves taking the milk directly from the dams, thus eliminating the possibility of scours from unsanitary pails or from other sources.

The work was inaugurated on January 28th, 1927, with five mature grade beef heifers. They had been bred to a pure bred Hereford bull during October and November previous. The work was thus planned so that it would be possible to take the heifers through the gestation and lactation period and at the same time arrange whereby they would be receiving the largest amount of cottonseed meal during the last half or more of the gestation period and be enabled to continue through four to six months of the lactation period in full production and in the best physical condition.

The following are the initial rations on which the five heifers were placed on feed January 28th, 1927:

No. 10	1 lb. C.S. meal
	5 lbs. C.S. hulls
	10 lbs. wheat straw
No. 11	1 lb. C.S. meal
	5 lbs. C.S. hulls
	10 lbs. wheat straw

This group thus received dry roughage exclusively whereas the following group received green rye in addition as later shown.

All of the heifers were kept confined in individual stalls during the progress of the work so that the amount of green feed received by the following group was under control at all times.

The second group was fed as follows:

No. 13	1 lb. C.S. meal
	5 lbs. C.S. hulls
	10 lbs. wheat straw
	5 lbs. green rye
No. 14	1 lb. C.S. meal
	5 lbs. C.S. hulls
	10 lbs. wheat straw
	5 lbs. green rye
No. 17	1 lb. C.S. meal
	5 lbs. C.S. hulls
	10 lbs. wheat straw
	5 lbs. green rye

These rations were increased gradually on the following dates: February 17th, and 24th, March 5th and 17th, May 5th and 23rd, June 7th and 26th, July 26th and August 8th until on this date they were receiving the following ration which continued to the close of the work on November 1st.

	Morning Feed	Evening Feed
No. 10	5½ lbs. C.S. meal	5½ lbs. C.S. meal
	3 lbs. C.S. hulls	3 lbs. C.S. hulls
	5 lbs. wheat straw	5 lbs. wheat straw
No. 11	5½ lbs. C.S. meal	5½ lbs. C.S. meal
	3 lbs. C.S. hulls	3 lbs. C.S. hulls
	5 lbs. wheat straw	5 lbs. wheat straw
No. 13	5½ lbs. C.S. meal	5½ lbs. C.S. meal
	3 lbs. C.S. hulls	3 lbs. C.S. hulls
	5 lbs. wheat straw	5 lbs. wheat straw
	5 lbs. green rye	
No. 14	5½ lbs. C.S. meal	5½ lbs. C.S. meal
	3 lbs. C.S. hulls	3 lbs. C.S. hulls
	5 lbs. wheat straw	5 lbs. wheat straw
	5 lbs. green rye	
No. 17	5½ lbs. C.S. meal	5½ lbs. C.S. meal
	3 lbs. C.S. hulls	3 lbs. C.S. hulls
	5 lbs. wheat straw	5 lbs. wheat straw
	5 lbs. green rye	

Only minor changes were made in the roughage fed, the chief difference in the rations being the amount of cotton seed meal which was fed finally on a basis of 11 pounds per animal daily.

All of the animals continued on these rations during the period up until November 1st except No. 13 which was eliminated on September 1st as will be explained fully later.

The following table gives a complete summary of weights showing the growth and development of both heifers and calves and further remarks on their condition at various times during the progress of the work.

It should be kept in mind that the heifers used in the work were fully matured when bred, their first calves dropped at three years of age being the ones involved in the data presented.

Table Showing Weights of Heifers

Date	Heifer No. 10	Heifer No. 11	Heifer No. 13	Heifer No. 14	Heifer No. 17
1-28-27	1040	1090	974	1294	1070
6-25-27	1050*	.....	.....	.....	.....
7-28-27	.....	.....	.....	1315*	.....
8-5-27	.....	1110*	.....	.....	.....
8-14-27	.....	.....	.....	.....	1010*
8-23-27	.....	.....	980*	.....	.....
9-12-27	920	1030	940	1130	920
11-1-27	830	970	**	990	840

* Weight at calving time.

** Slaughtered.

Table Showing Weights of Calves

Date	Calf No. 10	Calf No. 11	Calf No. 13	Calf No. 14	Calf No. 17
6-25-27	75	.....	.....	.....	.....
7-28-27	.....	.....	.....	77	.....
8-5-27	.....	68	.....	.....	.....
8-14-27	.....	.....	.....	.....	74
8-23-27	.....	.....	77	.....	.....
9-12-27	244	132 B	Dead	176	128
11-1-27	325	181 B	Dead	266	217

Condition of Cows and Calves at Calving Time

Heifer No. 10 calved on June 24th. She weighed 1050 pounds at this calving. She cleaned promptly and seemed to be normal otherwise. of bull calf, 75 pounds. It was active and apparently normal in every way.

Heifer No. 14 calved July 27th. She weighed 1315 pounds at date of calving. She cleaned promptly and seemed to be normal otherwise. Weight of calf (heifer), 77 pounds. Calf stood up, walked around and was otherwise apparently normal.

Heifer No. 11 calved August 4th. Cow cleaned without delay and otherwise in good condition. Weight of calf (bull) 68 pounds. Calf apparently normal in every way except it showed indications of blindness Weight of cow at calving 1110 pounds.

Heifer No. 17 calved August 14th. She weighed 1010 pounds at this time. She cleaned readily and was otherwise apparently normal. Weight of calf, (bull) 74 pounds. It was apparently normal.

Heifer No. 13 calved August 23rd when weighing 980 pounds. She cleaned without difficulty. Weight of calf, (bull) 77 pounds. Seemed to be normal in every way.

Practically without exception each of the calves equalled or surpassed the normal weights at various ages. The results, therefore, from this standpoint are rather conclusive.

The following table gives the feed intake during the entire period of 277 days.

Table Showing Feed Intake

Heifer Number	Cottonseed Meal	Cottonseed Hulls	Wheat Straw	Green Feed
10	2046	1564	2770	.....
11	2046	1564	2770	.....
13	1375	1198	2160	1080
14	2046	1564	2770	1385
17	2046	1564	2770	1385

With the exception of No. 13 which was discontinued on September 1st after calving on August 23rd, the calf dying two days later, each heifer ate slightly over one ton of cottonseed meal during the period. The average daily intake over the whole period for heifers No. 10, 11, 14 and 17, was 7.39 pounds each, whereas for the period extending from August 8th to November 1st, or 83 days, the total daily intake was 11 pounds each daily.

The blind calf from heifer No. 11 was from the group which did not receive any supplementary green feed. The calf from heifer No. 13 which died two days after birth was from the group receiving the supplementary

green feed. The eyesight of this calf, as far as could be determined was apparently normal. If death occurred from the effects of cottonseed meal, such effect was imbibed during foetal development.

The following is a report of an examination made of the eyes of the cows and calves used in the above project.

The eyes of the cows were pronounced normal in each case insofar as could be determined.

Calves No. 11 and 17 were examined, a description of the condition following.

Calf No. 11

This calf was found to be apparently blind except for some form perception. There is an exophthalmous which has not progressed to the point where the lids do not close readily. There is no conjunctivitis. The cornea is clear. The sclera is unusually thin, so much so that the choroid shows through, and gives to the sclera a definite dark color.

Examination of the fundus shows definite degenerative changes. The optic nerve is quite pale in color, fairly well outlined, there is no cupping. The vessels are definitely narrowed. There is considerable pigmentary change throughout the entire fundus, which is suggestive of retinitis pigmentosa. There is undoubtedly some area in which there is an abnormal heaping up of the choroidal pigment.

Microscopic examination of the eye at the post mortem shows essentially the same thing as was found before, except for the fact that there was very little evidence of choroidal degeneration. The optic nerve appeared to be unusually hard, and was cut with some difficulty.

Conclusions: It would seem from the findings in this case that we were dealing primarily with a subsided pathological change involving the optic nerve and retina. This condition simulated to a marked degree retinitis pigmentosa. The thin sclera was undoubtedly present from birth and one would feel that the changes, already described, occurred in utero.

Calf No. 17

The only evidence of any abnormality is the thin sclera.

The examination was made by Dr. V. M. Hicks, Raleigh, N. C.

Summary Statements

1. The five animals used in this experiment were quite uniform and although they were bred late in maturity, that is, at three years of age, all conceived to the pure bred Hereford bull used and dropped their calves quite uniformly.
2. There were no difficulties encountered in parturition, each of the heifers delivering their calves without aid, and each of them cleaned promptly and without any difficulty. This was somewhat contrary to popular opinion that cows fed heavily on cottonseed meal were likely to give premature birth to calves and further, develop difficulties after parturition.
3. With one exception, that is in the case of heifer No. 17, all of them weighed more when the calves were dropped than at the beginning of the work. Heifer No. 17 weighed 60 pounds less than at the beginning. In addition they all maintained their weight reasonably well during the suckling period considering the heavy drain on them. At the close of the work on November 1st all of the heifers were apparently in a thrifty condition.
4. All of the heifers apparently dropped normal calves except No. 13, the calf of this heifer living only two days. It weighed 77 pounds,

however, which is above the standard of weight at birth as shown by the table giving the normal weight of dairy Shorthorn cattle with which these heifers used would compare favorably. If this calf died from the effects of cottonseed meal such effect was, without question imbibed by the foetus.

5. All calves were normal in weight at birth except No. 11 which weighed 68 pounds or 5 pounds below normal. This calf from every standpoint except an apparent blindness at birth was normal in every way. There was no indication that the condition grew worse during the suckling period and the further post mortem examination made when the calf was 87 days old indicated that the eye conditions existed as a scar from pathological effects in utero. This would again indicate that the milk had no effect since the calf at slightly less than three months of age weighed 181 pounds or 7 pounds above normal.
6. All of the other calves, that is, No. 10, No. 14 and No. 17, developed normally in every way. Calf No. 10 weighed 75 pounds at birth, and at the age of 129 days or approximately four months, it weighed 325 pounds as against 225 pounds which is normal. Calf No. 14 weighed 77 pounds at birth and at 95 days of age which approximately three months it weighed 266 pounds as against 174 pounds which is normal. Calf No. 17 weighed 74 pounds at birth and at the age of 78 days which is approximately two and one-half months it weighed 217 pounds as against 154 pounds which is the average of the normal weights at two and three months old.
7. From the results of this work it would seem to indicate rather conclusively that there are no harmful effects resulting from calves suckling mothers receiving heavy rations of cottonseed meal. The average intake of cottonseed meal per animal daily except No. 13, the calf of which died two days after birth, was 7.4 pounds and for the last 84 days which comprised the major part of the suckling period they received 11 pounds daily. This is more than under most any circumstances would be fed to a breeding animal.
8. There was further apparently no difference in the effects of the cottonseed meal either on the original animals used or their calves except possibly that calf No. 11 which was blind at birth may have developed this condition due to the lack of green material. On the other hand, calf No. 13 which was from the lot receiving green material died at two days of age which would tend to offset the differences from this viewpoint.
9. The major objective in this work was rather clearly set out, that is, that no ill effects occur to the calves suckling cows which receive very heavy rations of cottonseed meal. In studying the growth curves or figures it should be kept in mind that the normal weights mentioned was for females, calf No. 14 being the only heifer in the group. Even after making sufficient allowance, however, for the difference in sex the results or comparisons are quite striking.

SOY BEAN HAY VERSUS ALFALFA HAY FOR WINTER MAINTENANCE OF SHEEP

This project while conducted with sheep in a general way serves as a guide as to the value of soy bean hay for other classes of live stock. This work followed a survey indicating that very large quantities of alfalfa hay were shipped into the State, most of it coming from far distant points.

The results are quite conclusive as shown in the following summary. The sheep used in this work have been continued in other lines of work and insofar as can be determined the after effects or residual condition

in the sheep fed the soy bean hay have been very favorable, in fact, normal insofar as any indications are concerned up to the present.

In the fall of 1926, 20 grade Hampshire lambs were purchased to use in a research project to determine the effect of permanent pasture, temporary pasture without grain and temporary pasture with grain on retarding the effect of stomach worms in sheep. The lambs were purchased beforehand in order that a previous knowledge could be had of their feeding and management. This made possible the outlining of a sub-project to be conducted during the wintering period. The one which had the greatest appeal was the comparison of alfalfa hay and soybean hay for carrying lambs through the wintering period. This seemed to be especially important since such great quantities of alfalfa hay is shipped into the State from the alfalfa districts in the far west and on the other hand that soy bean hay of such good quality can be produced in abundance at home. But little data is available on the actual value of soybean hay as compared with other hays under our conditions, and it seemed, therefore, that a project of this kind would bring out facts of much economic importance.

The improved flock showing size and type.

The lambs were divided into two equal lots on November 23rd, 1926. Each lamb was weighed individually and ear tagged in order that definite records could be kept on each animal. The lambs in lot I were fed 4 lbs. each of alfalfa hay once daily without grain and each of the lambs in the other lot 4 lbs. of soybean hay once daily without grain. They were continued on this ration until April 1st, 1927, a period of 130 days. No additional feed or grazing was provided during the period. Water and salt were kept before the lambs at all times. The tabulated results of the tests as given below show clearly the superior value of soy bean hay to alfalfa hay for winter maintenance under identical conditions.

Weight of Lambs and Rations

LOT I. Ration: Alfalfa Hay				Lot II. Ration: Soy Bean Hay			
Lamb No.	11-23-26	4-1-27	Gain per Lamb	Lamb No.	11-23-26	4-1-27	Gain per Lamb
1	67.0	81.0	14.0	10	92.5	120.0	27.5
2	80.5	94.0	13.5	11	81.5	98.0	16.5
3	60.5	78.0	17.5	12	57.0	89.0	32.0
4	100.5	109.0	8.5	13	65.5	75.0	9.5
5	49.5	57.0	7.5	14	85.0	91.0	6.0
6	76.0	83.0	7.0	15	87.5	116.0	28.5
7	102.0	103.0	1.0	16	62.5	65.0	2.5
8	69.5	85.0	15.5	17	71.0	85.0	14.0
9	64.0	66 0	2.0	18	78.0	100.0	22.0

Total average gain per lamb in Lot I _____ 9.6 lbs.
Total average gain per lamb in Lot II _____ 17.6 lbs.
Average daily gain per lamb in Lot I _____ .073 lbs.
Average daily gain per lamb in Lot II _____ .135 lbs.

The total period of maintenance was 130 days, thus showing the total average gain for each lamb in Lot I during the period to be 9.6 lbs. and Lot II 17.6 lbs., and the average daily gain per lamb to be .073 lbs. in Lot I, and .135 lbs. for Lot II.

The lambs in both lots remained thrifty throughout the experiment and while they were not fat they were in good condition to go on grass and make further gains during the summer grazing period.

STOMACH WORM CONTROL

The problem of stomach worm control is one of great importance, especially in the Southern states. Projects were conducted this past year both at the Central Station and at the Piedmont Branch Station with ten ewe lambs which were retained from the flock to replenish where it was necessary to eliminate older sheep.

The following results are quite conclusive, indicating that when sheep or lambs are maintained in good, vigorous condition by proper feeding, especially during the critical periods of June, July, August, September and October, the likelihood is not nearly so great that the stomach worm menace will develop to a point of seriously damaging the flock.

This project was one conducted in sheep management under the title of *Temporary Verus Permanent Pastures in Sheep Production and Their Relation in Stomach Worm Control.*

The following records give the results of the study made for determining the value of pastures under various conditions for maintaining breeding flocks and the further relation of stomach worms to permanent pastures which have not been used for sheep work formerly.

The three lots of sheep used were fed as follows:

Lot No. 1. 6 sheep on permanent pasture alone.

Lot No. 2. 6 sheep on temporary pasture without additional feed.

Lot No. 3. 6 sheep on temporary pasture with cottonseed cake.

Experiment continued from April 12th to November 1st, during the grazing season.

One-half of the lambs in each of the three lots were drenched with bluestone solution monthly throughout the summer season. They were weighed at intervals as shown in the table.

This is an especially important problem since it is possible to utilize grazing for such a long period of the year and since the excessive rainfall furnishes ideal conditions for intestinal parasites to thrive and perpetuate themselves.

The work was conducted this year with both lambs and yearling ewes, part of the work being located at the Piedmont Branch Experiment Station and otherwise at the Central Experiment Station.

Table Showing Results of Work—Central Farm

DRENCHED

Number	5 12	7 28	10 6	11 1	Gain or Loss
1	81	117	125	127	46
2	94	121	121	128	34
3	78	103	110	110	32
7	109	124	132	140	31
8	57	85	91	93	36
9	83	101	110	112	29
13	103	117	D	D	D
14	85	108	118	129	44
15	66	92	101	105	39

UNDRENCHED

Number	5 12	7 28	10 6	11 1	Gain or Loss
4	120	145	156	121*	1
5	98	130	134	137	39
6	89	127	135	139	50
10	75	95	102	105	30
11	91	114	116	119	28
12	116	124	133	D	21
16	65	D	D	137	D
17	85	103	104	115	30
18	100	125	133	135	35

Notes: Ewe No. 16 died on June 7th. She was posted but there were no characteristic lesions either from worms or from ration difficulties or effects. Weight of ewe 85 pounds.
Ewe No. 13 died on September 8th. The post mortem did not show any charactertistic lesions from any source. Weight of ewe 127 pounds.

Ewe No. 4 which weighed 121* on November 1st weighed 145 pounds on July 28th and 156 pounds on October 6th, thus showing consistent gains. Her reduced weight on November 1st was due to the fact that she was attacked by dogs on October 22nd and was injured to a considerable extent.

The average gain in weight during the season for the nine drenched ewes was 36.4 pounds, and for the undrenched ewes 29.2 pounds. As-

suming that ewe No. 4 would have maintained her weight of 156 pounds from October 6th to November 1st, the average gain of the undrenched lot would have been 33.6 pounds for the period. The drenched lot of ewes would have thus shown an average daily gain of 2.8 pounds per head more for the season than the undrenched lot.

All of the ewes which were on the permanent pasture without additional feed did exceptionally well. The average gain for the three drenched ewes was 37.3 pounds and for the undrenched ewes in this lot 41.6 pounds, assuming that ewe No. 4 had maintained her weight from October 6th to November 1st.

The Farm Flock

The average gain for the drenched ewes on temporary pasture was 36 pounds for the period and for the undrenched ewes 26.3 pounds. The drenched ewes on temporary pasture which received grain in addition made an average gain of 41.5 pounds while the undrenched ewes handled and fed under the same conditions made an average daily gain of 37.5 pounds for the period. Ewe No. 13 of the drenched group and ewe No. 16 of the undrenched group died during the progress of the work.

The following is a key to the lots and groups:

Ewes No. 1, 2, and 3, permanent pasture, drenched.
Ewes No. 4, 5, and 6, permanent pasture, undrenched.
Ewes No. 7, 8, and 9, temporary pasture, drenched.
Ewes No. 10, 11, and 12, temporary pasture, undrenched.
Ewes No. 13, 14, and 15, temporary pasture, grain, drenched.
Ewes No. 16, 17, and 18, temporary pasture, grain, undrenched.

This work indicates to a considerable extent that good feeding provided either by pasture or by pasture supplemented has a great deal to

do with maintaining health and thrift and otherwise controlling the effect of stomach worms.

The former work covering stomach worm control was conducted at the Central Experiment Station with mature sheep whereas the following was conducted with ten spring lambs. It is a known fact that lambs are especially affected with stomach worms and by conducting the two pieces of work in this way one has, in quite a large measure, served as a check on the other.

The lambs used were high grade select ewe lambs from the flock maintained on the Piedmont Branch Experiment Station and were largely comparable in breeding and type to the 18 yearling ewes used in the work on the Central Experiment Station Farm. These lambs were weighed and drenched every two weeks with a combination of bluestone and nicotine sulphate solution. Regular lamb doses were given, these consisting of 50 c.c. or 1¾ ounces.

The following table gives the results of the work, extending from August 1st, 1927, to November 12th of the same year, a period of 104 days.

Table Showing Results of Work—Branch Farm

(1) DRENCHED

Number	8 1	8 15	8 29	9 13	9 26	10 10	10 24	11 12	Gain or Loss
13	61	65	69	76	75	76	81	82	21
14	109	113	120	122	120	122	103	104	-5
15	121	101	106	106	112	112	120	122	1
16	108	95	97	97	103	104	110	112	4
17	119	100	104	104	110	112	116	117	-2

(2) UNDRENCHED

Number	8 1	8 15	8 29	9 13	9 26	10 10	10 24	11 12	Gain or Loss
10	122	106	110	113	113	112	116	117	-5
22	88	75	81	84	84	80	75	69	-19
23	110	98	102	107	106	106	107	107	-3
24	100	86	90	98	96	99	102	106	6
25	111	98	104	106	106	100	110	104	-7

This work was started on August 1st as soon after weaning as provision could be made for the work. The ten lambs were divided into two flocks of five each and numbered as recorded above. The five lambs in the first group were weighed and drenched every two weeks and those in the second group weighed only at the same time.

The lambs had the run of an alfalfa pasture and in addition were given one pound of a grain mixture per head daily.

The difference between drenching and not drenching in lambs is rather clearly brought out in this work. There is one feature which is particularly interesting. Lamb No. 13 was a late lamb and doubtless because of the fact that he was drenched it gained 21 pounds. Lamb No.

22 was also a late lamb but it was not drenched and shows a loss of 19 pounds. The work otherwise in the main indicates that if ewes lamb early and the lambs have an opportunity to get a good start in life before the season of the stomach worm menace comes on, they are much more likely to survive in good condition.

In the drenched lot, No. 14 and 17, showed an average loss of 3½ pounds per head for the period from August 1st to November 12th. In this same lot No. 15 and 16 showed an average gain of 2½ pounds per head for the period.

All lambs in the undrenched lot lost weight except No. 24 which gained 6 pounds during the period. The average loss per head for the four others was 8.5 pounds.

Although definite conclusions can not be based on this small number of lambs results quite clearly show that there is a difference between drenched and undrenched lambs, that late lambs are never advisable under any circumstances, but should they be late in coming that drenching is of material benefit.

The distinction as between the necessity of drenching lambs and yearlings or older sheep is further quite clearly shown. The results are quite in keeping with what has been found elsewhere principally in the government work at Washington although never before has experimental work been conducted under our conditions to determine the facts as they exist here.

BEEF CATTLE PRODUCTION, FEEDING, GRADING, AND PASTURE WORK

R. S. CURTIS, *In Charge*

This project is a combined project in building up a herd of beef cattle under Eastern North Carolina conditions and under a plan of management which will fit the average farmer of this section, at the same time making a study of the value of native and tame pastures and other feeds necessary for maintaining herds in a practical manner.

Plans for this work have been made for several years but it was not actually started until the cattle tick was completely eradicated from the eastern section of the State. The results this year, considering that it is a pioneering project, are very gratifying. Some valuable data have been secured on the value of reeds for maintenance and growth.

BEEF CATTLE WORK AT BLACKLAND BRANCH STATION

Purpose. This work was inaugurated immediately after the cattle tick had been completely eradicated from Eastern North Carolina. The purpose is as follows:

1. To determine the best plan for developing the herd of beef cattle under Eastern North Carolina conditions.
2. To determine the extent which beef cattle production can be fitted into the future farming program of this section.
3. To measure the value of various pasture grasses including both native and tame varieties when grazed under field conditions.
4. To work out a system of growing and finishing beef cattle for market in order that the greatest profits may be secured, and at the same time to permanently improve the soil and crop growing conditions.

Plan. A pure bred Hereford bull is to be used on the native cattle of Eastern North Carolina, thence following the regular grading up process, and at the same time weeding the females vigorously in order that improvement may be brought about in the most rapid manner. The best of the females are to be retained from each successive generations to replace the original seed stock.

All bull calves and the less desirable of the females will be sold for beef in such a way as to return the greatest net profit after they have been used insofar as possible in securing the required data.

History of Animals Used. The cattle used in this initial work were native to Eastern North Carolina. They were purchased from Mr. G. S. Gray of Holly Ridge. Twenty average females were selected from his herd of about five hundred at a cost of $27.00 per head F.O.B. shipping point. The best cattle were not selected as the idea from the beginning was to use an average of the cattle found in this section.

The cattle reached the Branch Experiment Station on October 2nd. They were weighed and each animal identified with a neck strap and number in order that each animal could be identified throughout the time they remained in the herd.

Subsequent Treatment. The pure bred Hereford bull to be used at the head of the herd was shipped from Raleigh to Wenona on November 15th, 1926. The cattle were carried through the first winter without shelter as the barn was not constructed until rather late in the winter. The winter season was mild, however, and they went through in good condition.

From the time the heifers reached the farm on October 2nd and up until January 18th, 1927, they were wintered on reed pasture. On the latter date they were put in the corn fields where they remained until May 12th, 1927, when they were again placed on the reed pasture. They were left on this particular 80 acre field until August 31st when they were transferred to a rented tract of reed land.

Table Showing Weights and Gains

PERIOD OCTOBER 2, 1926 TO JANUARY 18, 1927

No. Cattle	Initial Weight	Final Weight	Gain
20	9450	10860	1410

No. days on reed pasture, 108.
Total gain during this period, 1410 pounds.
Total gain per head during this period, 74.2 pounds.
Average daily gain per head during this period, .68 pound.

PERIOD JANUARY 18, 1927, TO MARCH 14, 1927

No. Cattle	Initial Weight	Final Weight	Gain
19	10310	8820	-1490

No. of days in the corn fields, 45.
Total loss during this period, 1490 pounds.
Total loss per head during this period, 78.4 pounds.
Average daily loss per head during this period, 1.74 pounds.

PERIOD MARCH 14, 1927, TO MAY 12, 1927

No. Cattle	Initial Weight	Final Weight	Gain
19	8820	9135	315

No. of days fed grain and miscellaneous farm gleanings, 49.
Total gain during this period, 315 pounds.
Total gain per head during this period, 16.6 pounds.
Average daily gain per head during this period, .34 pounds.

Note: In studying the above tables it will be noticed that in the beginning there were 20 cattle whereas at the beginning of the second period there were only 19 head. This accounts for the difference in the final weight of the cattle as shown in the first table, and the initial weight of the cattle as shown in the second table.

PERIOD MAY 12, 1927, TO AUGUST 31, 1927

No. Cattle	Initial Weight	Final Weight	Gain
19	9135	9660	525

No. of days on reed pasture, 112 days.
Total gain during this period, 525 pounds.
Total gain per head during this period, 27.6 pounds.
Average daily gain per head during this period, .25 pounds.

PERIOD AUGUST 31, 1927, TO NOVEMBER 9, 1927

No. Cattle	Initial Weight	Final Weight	Gain
13	6780	7320	540

No. of days on reed pasture, 70 days.
Total gain during this period, 540 pounds.
Total gain per head during this period, 41.5 pounds.
Average daily gain per head during this period, .59 pounds.

Note: It was impossible to weigh all of the cattle as they could not be gotten up to do so at the time the 13 were weighed. The figures above, therefore, represent the averages of the 13 cattle.

Since October 2nd, 1926, to November 9th, 1927, these cattle have run on reed pasture exclusively with the exception of 45 days in the corn fields and 49 days during which time they were fed grain and miscellaneous farm gleanings. The average weight of the cattle on October 2nd, 1926, was 472.5 pounds and their average weight on November 9th, 1927, was 563 pounds, thus showing a gain of 90.5 pounds per head during this period. Considering that these are breeding cattle most all of which have raised calves, this is an excellent showing for the reed pasture.

At no time while they were on reed pasture was there a loss in weight. The only time when weight was lost was during the 45 days when they ran in the corn fields. The total loss during this period was 1490 pounds, 78.4 pounds per head, or 1.74 pounds per head daily.

FINANCIAL STATEMENT

To 20 native bred heifers at $27.00 each	$ 540.00
Freight on cattle to farm at Wenona	39.00
Pure bred Hereford bull	75.00
Freight on bull to farm at Wenona	13.20
To 450 lbs. cottonseed meal at $40.00 per ton	.9.00
800 lbs. cottonseed hulls at $8.00 per ton	3.20
2 tons hay at $15.00 per ton	30.00
1 ton shucks at $5.00 per ton	5.00
Freight on meal and hulls	3.12
Total outlay	$ 717.52
By 1 calf sold to farm at $10.00	10.00
15 calves sold to butcher at $18.40 per head	276.00
By value 19 heifers at $27.00 each	513.00
By value 1 pure bred bull at $75.00	75.00
Value of present herd plus yearly income	$ 874.00
Net income for year	$ 156.48

Note: The loss of one heifer at the beginning of this work reduced the total net income for the year by $27.00. Otherwise, it would have been $183.48.

CALF RECORDS

It has been extremely difficult to get data on the calves at times as well as on the heifers. The following table, however, brings out quite clearly the results to be expected on calves of this breeding and under the conditions which they were produced.

	Jan. 18	March 14	May 12	Aug. 31	Nov. 9
Average weight	60	65	105.3	232	281.5

The averages, of necessity, were made on small numbers in the beginning, increasing as the calves were dropped. The averages were made on two calves January 18th, on three March 14th, on fifteen May 12th, on fifteen August 31st and on ten November 9th. The same difficulty applied here as with the heifers, it being impossible to get them up for weighing on the latter date.

All of the calves have been sold to a local butcher at 13 cents per pound dressed weight. Nine have already been taken, these dressing 1274 pounds which at 13 cents amounts to $165.62.

The weights on the remaining heifers and calves will be made available somewhat later.

HEREDITARY STUDIES IN SHEEP

It is generally accepted that sheep respond readily and quickly to improvement. However, tangible facts are not available for use in developing the industry, especially where the very lowest types of breeding ewes

are used. The work conducted at Statesville has from the viewpoint of using medium or average bred ewes shown very conclusively the results which can be obtained.

This particular project is being conducted with Eastern North Carolina ewes. They will be bred to a pure bred ram and accurate records consisting of photographic and written history showing the type, weights, gains, and otherwise complete records on the length, fineness and tensile strength of the wool will be kept.

Photographs have already been made of the native ewes and lambs from scrub rams. The original weights have been taken and the ewes have been bred to a pure bred Shropshire ram. The lambs have been sold in accordance with the plan after the necessary records were taken.

North Carolina needs a safe and stable development of the sheep industry. Lambs like the above grown on the college farm at Raleigh should be saved for this purpose. The sheep population of North Carolina has declined from 300,000 to 100,000 in the last few years.

Otherwise, the project is in its initial stages to be followed out according to the provisions in the project. The best practices in sheep production will be followed, including change of pastures and the specific treatment for controlling stomach worms.

PERMANENT PASTURE

Much work has been done in the past largely through plot work to determine the kind of grasses, rate of seeding, and the amount of harvested forage which various grasses alone and in mixtures will produce. This, however, unfortunately has tended to view the problem from the one angle of production, leaving the most important problem of palatability, carrying capacity, and nutrition insofar as animals are concerned out of the question.

After a great deal of preliminary discussion, more largely during the last four or five years, some headway has been made by providing pastures for maintenance and otherwise for securing experimental data on the latter problems mentioned. This work will be started in the spring of 1928 as an experimental pasture between the sheep barn and the poultry plant at the Central farm. The original pasture seeded and financed by the Animal Industry Division in 1923 has indicated clearly that good pastures can be made even under difficult circumstances.

DAIRY INVESTIGATIONS

Projects under the supervision of this office are conducted at the Central Dairy Research Farm, Raleigh, the Mountain Branch Experiment Station at Swannanoa and the Coastal Plains Branch Experiment Station at Willard.

A project in co-operation with the Veterinary Division of the North Carolina Department of Agriculture to study methods of eradication and control of bovine infectious abortion is conducted on twenty representative dairy herds scattered over the State.

Cottonseed meal studies I, II, and III, are also conducted at the Central Dairy Research Farm.

DAIRY CATTLE FEEDING STUDIES A

CENTRAL DAIRY RESEARCH FARM

This is a study of the effect of feeding and management on quantity and cost of production.

Four cows were selected from a herd which had been in a cow test association. The cows had been fed a very limited concentrate ration part of the time and during the remaining time were limited to roughage or to pasture.

The cows are now receiving a limited ration that can be grown on farms of this State, with pasture during the pasture months. The first lactation period at this station is incomplete.

ORIGINAL OWNERS RATION	EXPERIMENT STATION RATION	
1. Shorts	Corn	400 lbs.
2. Cottonseed meal	Cottonseed meal	300 lbs.
3. Cottonseed	Wheat bran	200 lbs.
4. Stover	Crushed Oats	100 lbs.
5. Hay	Soybean hay	
6. Cottonseed hulls	Cottonseed hulls	

The original owner fed the concentrates irregularly and, in case the pasture was good, no concentrates were fed.

PRODUCTION ORIGINAL OWNER				PRODUCTION EXPERIMENT STATION			
No. of Animal	Months in Lactation	Milk	B. F.	No. of Animal	Months in Lactation	Milk	B. F.
21	10	2905	142	21	7	5524	309.3
22	12	3182	133	22	4	2690	126.4
23	12	2288	100	23 Died			
24	11	2919	150	24	6	3698	192.2

This project is to continue for two lactations.

BOVINE INFECTIOUS ABORTION

Bovine infectious abortion, its eradication and control is one of the major problems facing the dairy industry of this State. During the past eight months the Office of Dairy Investigations of the North Carolina Experiment Station has been co-operating with the Veterinary Division of the North Carolina Department of Agriculture in a study of this problem.

This work has been undertaken with twenty herds, four of which gave complete negative results to the first blood test. The negative herds are tested every six months.

The herds which contain reactors are tested every sixty days, all reactors being separated from the negative animals. A few exceptions to this plan are made where the breeder co-operating wants to try the recommendations in regard to sanitation and hygiene and let the disease limit itself by building up a herd immunity to the infection present. In this case no new additions are to be made to the herd.

The following recommendations are given to guide in the management of all herds.

1. **Maternity or Isolation Stalls.** In all herds provision should be made for maternity or isolation stalls. These stalls should be constructed so the walls and floors can be easily and thoroughly cleaned and disinfected. The partitions between stalls should be solid, preventing all communication between animals. The praturient cow or any animal showing a discharge should be placed in a stall which has been cleaned and disinfected. This animal should be kept in this stall until there is no evidence of a discharge. After removal takes place the stall should be cleaned and disinfected again and put in shape for a new animal.

Care of the Young Herd. The calves from the infected herd should be placed in the clean herd one month after the feeding of milk from the infected herd has been discontinued. This time should be allowed the calf to rid itself of the abortion organisms which may be in its intestinal tract.

All animals of breeding age should be blood tested every sixty days until there are no further reactors. After the negative herd passes two clean tests the intervals between tests may be increased to six months.

All purchases are to be made from clean herds or purchased open and isolated until two blood tests can be run with at least a thirty day period between them. In case pregnant animals are purchased they should be isolated until thirty days after calving. This is necessary because pregnant individuals which are infected sometimes fail to react until after calving.

DAIRY HERD DEVELOPMENT

COASTAL PLAINS BRANCH STATION

Herd improvement by the selection of bulls with the ability to transmit tendencies for increased milk secretion is not an easy task. The real value of a herd sire cannot be determined until it is possible to study the production records of his progeny.

The selection of sires for this herd has been very fortunate to date.

Eminent 19th 78620, a gold medal bull, was followed by Rumina's King 160969, a silver medal bull with strong possibilities for a gold medal. Rumina's King was followed by the Distinguished Eminent 222775 whose daughters give much promise.

Selection of sires to keep the herd average going upward of 300 pounds of butter-fat is more difficult and the chances of making the wrong selection are far greater than when the herd is working toward the 300 pound mark.

In this study five lactation records have been added for Eminent 19th's daughters and nineteen for the daughters of Rumina's King. The daughters of the Distinguished Eminent are just beginning to freshen.

Herd Averages

	Milk	Per Cent	Butter-fat
1924	6,371.6 lbs.	5.23	337.14 lbs.
1925	6,168. lbs.	5.17	310.64 lbs.
1926	7,354. lbs.	5.06	367.80 lbs.

Official Test Records

Eminent's Fern Lucile 562998 Class AA ____ 640.00 lbs. B. F.
Eminent's Queen Betty 562994 Class AA ____ 693.33 lbs. B. F.

Value of Fly Repellants in Maintaining Summer Milk Production. An experiment was conducted during the past summer to study the effect of a fly repellant as an aid in maintaining summer milk production. Two lots of cows were sprayed by the double reversal method for three periods of twenty days each, with a preliminary period of five days before each record. Both lots received the same grain mixture, which was fed according to production, and they were pastured with the herd. The average grain consumption was nine pounds per day.

The results were slightly in favor of the use of the repellant. The difference in the results from the two groups, however, was not marked enough to justify any conclusions. This work will be repeated during the summer of 1928.

Dairy Cattle Feeding Studies. A feeding trial was conducted during the winter of 1926-27 to compare a simple and a complex concentrate mixture for economical milk production. The trial was conducted for three thirty day periods, each preceded by a ten day transition period. Two comparable groups of five cows each were used.

The feed consumption for the two groups was very near the same, the simple ration giving slightly better results. A difference in cost of over $6.00 per ton gave it a decided advantage on the basis of economy of production. This work will be repeated during the winter of 1927-28.

ECONOMY OF SIMPLE AND COMPLEX RATIONS

MOUNTAIN BRANCH EXPERIMENT STATION

The general plan of this experiment in each of the three trials was similar in every way and provided for placing of comparable animals in each group. Cows in normal lactation and as far from freshening and drying up were used where possible. When it was necessary to use an animal

about to freshen in one group an animal in a similar state was also placed in the other group. All changes in health were properly recorded. The two lots were grouped for comparison in respect to age, inherent ability as determined by previous records, size and stage of lactation. All animals used in this experiment were Jerseys and of the same breeding.

The experiments were divided into three periods of thirty days each. Each thirty day period was preceded by a ten day transition period to accustom the cow to the ration to be fed subsequent periods. Each lot was fed one of two rations experimented with during the first period, and the rations were reversed during the second period so as to place all cows on both rations, allowing a direct comparison. During the third period they were reversed again, allowing a double checking of data which tends to overcome any difference that might exist in individuality, productivity, or other conditions in the two lots of cows.

The following are the two rations fed. One trial has been completed and no data can be given until it is verified by further trials.

Complex Ration		Simple Ration	
Peanut meal (choice)	100 lbs.	Corn (ground)	400 lbs.
Cottonseed meal	260 lbs.	Cottonseed meal	300 lbs.
Linseed meal O. P.	280 lbs.	Wheat bran	200 lbs.
Corn distillers dried grains	200 lbs.	Crushed oats	100 lbs.
Corn gluten feed	500 lbs.		
Wheat bran	200 lbs.		
Ground oats	100 lbs.		
Hominy feed	200 lbs.		
Molasses—cane	100 lbs.		
Steamed bone meal	20 lbs.		
Calcium carbonate	20 lbs.		
Salt	20 lbs.		

Dairy Herd Development. This is a study of progress made in the improvement of a purebred dairy herd by the use of young sires of good breeding. Additional data has accumulated during the past year.

Seven lactation records on daughters of Eminent 19th 78620, gold medal bull, and thirteen lactation records on daughters of Rumina's King 160969, silver medal bull, have been added to the data. This herd has a very good breeding history and has passed two clean blood tests for bovine infectious abortion. The daughters of Majesty's Eminent Raleigh 208352 do not give promise of equaling their dams in production. They show no improvement in type and lack some of the refinement present in their dams.

Sybil's Gamboge of Swannanoa 254225, a young sire whose ancestry gives much promise of results in production and type, has been purchased for use at this station.

Herd Average

Year	Milk	Per Cent.	Butter-fat
1924	5,594.66 lbs.	4.96	274.69 lbs.
1925	7,080.43 lbs.	4.76	334.62 lbs.
1926	8,399.7 lbs.	5.56	403.67 lbs.

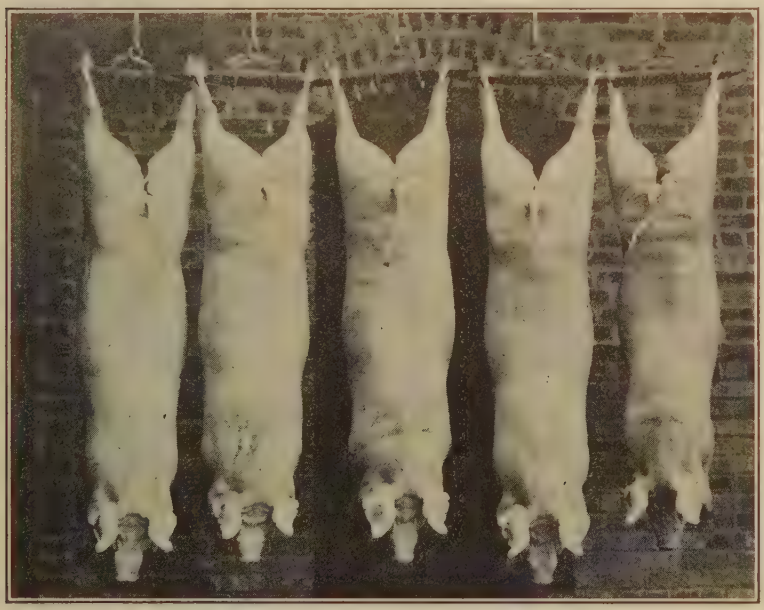
Official Test Records

Eminent's Happy Girl	562993	Class AAA	498.12
Eminent's Happy Girl	562993	Class AAA	498.12
Eminent's Foxy Eva	562990	Class A	545.28
Eminent's Tidy Louise	562991	Class AAA	557.42
Pender Eminent Lass	1369043	Class AAA	467.77

The herd development work shows that improvement by untried sires is a slow and uncertain process.

Young mails, though carefully selected, often fail to transmit high production. When selection for both production and type is attempted with limited funds the task is exceedingly difficult.

Value of Fly Repellants in Maintaining Summer Milk Production. This is a study to determine the value of fly repellants on cows in maintaining summer milk production. Two groups of five cows each comparable for breed, type, age, size, stage of lactation and productive capacity were used. The double reversal system of three experimental periods of twenty days each, with five day preliminary periods preceding each, was used. The results were slightly in favor of the use of the spray. This work will be repeated during the summer of 1928.



Cooled and Ready for the Pork Barrel.

SWINE INVESTIGATIONS

EARL H. HOSTETLER, *In Charge*

Projects under the supervision of the Office of Swine Investigations are being conducted at the Swine Research Farm, Raleigh; the Coastal Plains

Branch Station, Willard; the Upper Coastal Plains Branch Station, Rocky Mount; and the Blackland Branch Station, Wenona.

Only two sows and one boar are kept at the farm at Willard, but there are ten to twelve sows kept on each of the other farms for the purpose of producing pigs for experimental work.

A complete list of the projects, by farms, together with the object, plan and record, are as follows:

SWINE RESEARCH FARM, RALEIGH

I. Soft Pork.—Earl H. Hostetler and J. O. Halverson

The object of this project was to determine the hardening effects of corn, and corn and cottonseed meal (6:1) on the bodies of pigs, of 35 lbs. and 60 lbs. initial weight, that have been made soft from previous feeding on peanuts.

Plan: On Softening Feed

All pigs will be fed a peanut ration until they have ingested enough feed to become soft or until they have attained the weight at which they are to be changed to hardening feed.

On Hardening Feed

Individual Feed—Group I. It is proposed to use 6 pigs of 35 lbs. each initial weight, 3 (Nos. 1, 2, 3) of which will be given corn during the hardening period. The other 3 pigs (Nos. 4, 5, 6) will receive corn and cottonseed meal (6:1).

These pigs are to be changed to the hardening ration at a weight not exceeding 90 pounds.

Group II. The six 60 lb. pigs initial weight, having attained a weight not exceeding 110 lbs. each, are to be changed to hardening feed similar to Group I. Pigs 7, 8, 9, will receive corn; pigs 10, 11, 12 will receive corn and cottonseed meal (6:1).

Lot Feeding

Group I. The twelve 35 lb. pigs receiving peanuts are to be individually changed to corn and cottonseed meal (6:1) as soon as they attain a weight of 90 lbs.

Group II. The twelve 60 lb. pigs initial weight on peanuts are likewise individually changed at a weight not exceeding 110 lbs. to corn and cottonseed meal (6:1).

When finished all pigs will be shipped to Beltsville, Md., for slaughter.

Record. Fourteen pigs have been fed individually, and 24 have been fed by groups. All of these 38 pigs have been slaughtered and the effect on body carcass fat, of feeding cottonseed meal with corn, is reflected in the melting point, iodine number, and to a lesser extent in the refractive index. Cottonseed meal fed with corn exhibited hardening effects on pigs when fed in the ratio of 1 to 6 when the previous ingestion of peanut oil varies between 35 and 45 pounds.

II. A Comparison of Protein Supplements When Fed Under Temporary Pasture Conditions

Object. To determine:

(a) The value of different protein supplements when self fed to pigs on soybean pasture.

(b) The value of soybean pasture for fattening pigs that are full fed free choice a grain ration of shelled corn, fish meal and mineral.

Plan. To use not less than ten 65 lb. pigs in each lot fed as follows:

Lot 1—Shelled corn, fish meal and mineral.
Lot 2—Shelled corn, fish meal and mineral.
Lot 3—Shelled corn, soy bean oil meal and mineral.
Lot 4—Shelled corn, cottonseed meal and mineral.

All four lots will be fed their feed, free choice from self feeders, and Lots 2, 3, and 4 will be allowed to graze soybean pasture in addition, but Lot 1 will be kept in a dry lot.

Record. The average daily gains, and the feed consumed per cwt. gain are as follows:

Lot 1	1.23 lbs.	458 lbs.
Lot 2	1.51 lbs.	380 lbs.
Lot 3	1.45 lbs.	384 lbs.
Lot 4	1.39 lbs.	373 lbs.

The pigs in Lots 2 and 3 failed to make any use of their soy bean pasture but the pigs in Lot 4 consumed their allotment of one acre.

III. Cost of Raising Pigs to Weaning Time (8 weeks)

Object. To determine the cost of producing pigs to weaning age or eight weeks.

Plan. To keep an accurate record of the amounts and cost of all feeds used for each sow and litter from the time the sow is bred until the pigs are weaned at eight weeks. Weights will be taken on the sow at the time she is bred, when she farrows, and when the pigs are weaned. Weights will be taken of the pigs when they are farrowed and when they are weaned.

Record. Summary of feed and labor for 33 sows at Raleigh, Rocky Mount, and Wenona for 1926.

11587.00 lbs.	corn in shuck at $1.12 per bu.	$ 173.05
4472.00 lbs.	ear corn at $1.12 per bu.	71.55
29702.70 lbs.	shelled corn at $1.12 per bu.	594.06
6363.30 lbs.	ground oats at $.64 per bu.	127.26
12791.40 lbs.	wheat shorts at $40.00 per ton	255.82
7588.15 lbs.	fish meal at $70.00 per ton	265.58
1694.25 lbs.	linseed oil meal at $64.00 per ton	54.22
378.50 lbs.	mineral at $20.00 per ton	3.78
1023.30 hrs.	labor at $.30 per hr.	306.99
	Total	$1852.31

Record of Pigs from 33 Sows Shown Above

Number of pigs farrowed	538
Number of pigs farrowed per sow	16.3
Number of pigs weaned	385
Number of pigs weaned per sow	11.7
Average weight per sow at farrow	386.6

Average weight per sow at weaning	363.9
Loss during suckling period	22.7
Average weight per pig at weaning (8 weeks)	27.9
Cost per pig at 8 weeks of age	$ 4.81

Price of Feeds

Corn	$ 1.12	per bu.
Oats	.64	per bu.
Shorts	40.00	per ton
Fish Meal	70.00	per ton
Linseed meal	64.00	per ton
Minerals	20.00	per ton
Labor	.30	per hour

IV. Cottonseed Meal for Fattening Pigs

Object. To determine the effect of self-feeding an equal mixture of cottonseed meal and fish meal, to fattening pigs, as a protein supplement to corn.

Plan. To divide a given number of pigs (spring farrowed) into two equal lots, self-feeding free choice one lot on corn, fish meal and mineral, and feeding the other lot in exactly the same manner except that the protein supplement in the second lot will consist of equal parts of fish meal and cottonseed meal instead of fish meal alone. These pigs should be started on feed about June 15th and the experiment closed and the pigs marketed between September 1 and 15. The usual photographs and weights will be taken of the pigs on this experiment, i.e. at the beginning and at the close and additional weights at 14-day intervals.

Record. Sixteen pigs averaging 90 lbs. in weight were carried for 73 days on this experiment. Eight pigs in Lot I were self fed free choice shelled corn, fish meal and mineral and made an average daily gain of 1.49 lbs. and consumed 432 lbs. of feed for each 100 lbs. of gain. Eight pigs in Lot 2 were self fed free choice shelled corn, fish meal one-half plus cottonseed meal one-half, and mineral. They made an average daily gain of 1.60 lbs. and consumed 412 lbs. of feed for each 100 lbs. gain.

I. Cottonseed Meal for Fattening Pigs—College Herd, Raleigh

Object. To determine the effect of self-feeding on equal mixture of cottonseed meal and fish meal, to fattening pigs, as protein supplement to corn.

Plan. To divide 30 spring farrowed pigs into two equal lots, self-feeding free choice one lot on corn, fish meal and mineral, and feeding the other lot in exactly the same manner except that the protein supplement in the second lot will consist of equal parts of fish meal and cottonseed meal instead of fish meal alone. Individual weights will be taken of the pigs on this experiment at the beginning and at the close and additional weights at 14 day intervals. This experiment will be duplicated with fall farrowed pigs.

Record. The pigs on this experiment were carried for 84 days, with the pigs in Lot 1 making an average daily gain of 1.28 lbs. and consuming 347 lbs. of feed for each 100 lbs. of gain, while the pigs in Lot 2

(cottonseed meal) made an average daily gain of 1.50 lbs. and consumed 351 lbs. of feed for each 100 lbs. of gain.

It is significant that the pigs in Lot 2 consumed a total of 397 lbs. of cottonseed meal for a period of 84 days or 4.7 lbs. per day without any serious effects. The ration was cheapened somewhat by the use of cottonseed meal since the cost per cwt. gain in Lot 2 was only $7.83 as compared with $8.04 in Lot 1.

I. "Hogging Off" Immature Corn—Upper Coastal Plain Branch Station, Rocky Mount

Object. To determine the value of corn when "hogged off" in the dough stage.

Plan. Fifty-seven 83 lb. pigs and two varieties of corn were used in this experiment. The first variety, Norfolk Early Market, was used solely because of its early maturing qualities, then this was followed by the Jarvis' Golden Prolific variety which matures slightly later and was thoroughly matured before the pigs had finished hogging it down. The pigs were turned into the first field when the corn was in the dough stage and throughout the experiment fish meal and mineral were supplied from a self feeder to supplement the corn.

Record. Due to unfavorable weather conditions the corn used in this experiment made a very poor yield and the results were, therefore, inferior to previous years. The average daily gain per pig was 1.04 lbs. and each acre of corn produced only 193 lbs. of pork.

II. "Hogging Off" Mature Corn and Soy Beans

Object. To study the value of using:

(1) Fish meal and mineral as supplements to corn and soy beans hogged off.

(2) Mineral alone as a supplement to corn and soy beans hogged off.

Plan. To divide the available fall pigs into two groups. Self feeding fish meal and mineral free choice to one group and self feeding mineral alone to the other group. The corn and soy beans for both lots to be mature when the pigs are turned into the fields.

Record. The addition of fish meal was apparently responsible for better gains in Lot 2, since the pigs in this group made 363 lbs. of pork on each acre of corn and soy beans with the addition of 83 lbs. of fish meal and 11 lbs. of mineral while the pigs in Lot 1 made only 256 lbs. of pork for each acre of corn and soy beans and consumed in addition 32 lbs. of mineral.

I. Soybean Oil Meal for Fattening Pigs—Blackland Test Farm, Wenona

Object. The object of this experiment was to determine if an equal mixture of soybean oil meal and fish meal would be as satisfactory a protein supplement to corn as fish meal alone.

Each group of pigs was kept in a dry lot and allowed to choose the feeds from different compartments of self-feeders. Equal amounts of the soybean oil meal and fish meal used in Lot 2 were mixed together before being put in the self-feeders.

Plan. Two separate trials were conducted during the past year with this project. In the first trial sixty 90 lb. pigs were used and in the second trial fifty-five 119 lb. pigs were used. In each trial the pigs were divided into two groups and self fed, free choice as follows:

Lot 1—Shelled corn, fish meal and mineral.
Lot 2—Shelled corn, soybean oil meal ½, fish meal ½, and mineral.

A summary of the two trials is shown in the following tables:

Table I. First Trial—June 16-August 10, 1926—55 days

Lot No.	No. of Pigs	Aver. Initial Wt.	Aver Daily Gain	Feed and Cost per Cwt. Gain				
				Shell Corn	Fish Meal	S. B. Meal	Min.	Cost
1	30	91	2.07	323	22	0	1.6	6.51
2	30	90	2.09	293	25	25	1.4	6.71

Corn, 85c per bu.; fish meal $65.00; S. B. meal, $50.00; and minerals $20.00 per ton.

Table II. Second Trial—January 6 to March 14, 1927—67 days

Lot No.	No. of Pigs	Aver. Initial Wt.	Aver. Daily Gain	Feed and Cost per Cwt. Gain				
				Shell Corn	Fish Meal	S. B. Meal	Min.	Cost
1	27	119	2.28	369	17	0	1.7	5.52
2	28	119	2.22	358	19	19	1.8	5.86

Corn, 75c per bu.; fish meal, $66.00; S. B. meal, $44.00; and minerals, $20.00 per ton.

ANIMAL NUTRITION

By J. O. Halverson and F. W. Sherwood

Nutritive Properties of the Peanut

A Biological Study of the Distribution of Vitamin B

The parts used in this work are: the whole shelled peanut, the sheath (red skins), the germ (hearts) and the cotyledon (splits).

The work divided itself as follows:

I. The amount of peanuts or its structural parts supplying Vitamin B in the ration necessary to support growth on both the blanched and on the raw peanuts.

II. Comparative amounts of peanuts or its products fed separately in order to estimate the amount of Vitamin B present in both the raw and the blanched parts.

Results to date indicate unequal distribution of Vitamin B, being richest in the sheath (red skins), least in the cotyledon, (splits), and moderate in the germ (hearts).

COLONY RATION STUDIES

By J. O. Halverson and F. W. Sherwood

Effect on Longevity, Reproduction and Rearing of Young

Of 3 rations fed to a number of rats, one ration in these studies was outstanding. Four modifications of this successful ration, are being fed in order to determine which of the ingredients caused this ration to be

superior to the others. This work is being continued until sufficient data have been obtained for a careful statistical study of the results.

An attempt to formulate a satisfactory ration requiring neither whole milk nor green vegetables (cabbage in this case) is being carried on as well as reproduction and lactation studies with the peanut.

Rats are raised through successive generations on the peanut ration supplemented. The effect of the peanut ration on the life cycle, if not adequately or properly balanced, is shown by a growth stunting effect, inability to rear the young or they may be much stunted if raised beyond the age of weaning.

R. H. RUFFNER,
Head, Animal Husbandry Department.

EXPERIMENTAL WORK IN HORTICULTURE

This report is dedicated to the memory of Wilbur Fisk Massey, the first Horticulturist of the North Carolina Agricultural Experiment Station and whose term of service extended from 1889 to 1905.

Teacher and friend of the Southern farmer, beloved by all, his years were rich in achievement in increasing the knowledge of scientific agriculture and horticulture and whose life stands as an inspiration to those who desire knowledge ond who wish to serve.

A man whose morning prayer for forty years was "May I this day help someone to a better use of God's soil".

WILBUR FISK MASSEY

Wilbur Fisk Massey, the first Horticulturist of the Experiment Station, was born in Accomac county on the eastern shore of Virginia, September 30, 1839. He was the son of Reverend James A. and Annie Massey. His preparatory education was received at Washington College, Md., and he attended Dickinson College, Pa., and Union College, New York. From the latter institution he was graduated with the degree of C.E.

Professor Massey married Sarah E. M. Phoebus, of Somerset county, Maryland, on May 4, 1861. His first wife died and he later married Orrilla J. Phoebus, sister of the first wife, on April 4, 1876. In his early life he engaged in railroad construction in the West until the time of the Civil War, when he returned to Virginia and served as a Confederate soldier. For twenty years after the war ended he was engaged in farming and gardening. From 1885 until his death he was engaged in agricultural and horticultural education, first as a teacher of agricultural students in schools and colleges, later as a teacher of adult farmers through farmers' institutes and the farm press. His first instructional work was done at the Miller Manual Training School at Albemarle, Va. From 1889-1905 he was on the faculty of the North Carolina College of Agriculture and Mechanic Arts and was horticulturist of the Experiment Station.

Leaving the North Carolina A. & M. College in 1905, after sixteen years of service, Professor Massey was for several years editor of the Practical Farmer of Philadelphia. Resigning that work he immediately connected himself with the Progressive Farmer, and for fifteen years until his death on March 30, 1923, he exercised through the agricultural press great influence on the agriculture of the South. He was in his eighty-fourth year at the time of his death and his life has been one of inspiration to his fellows who desire knowledge and who want to serve.

Perhaps as good a biography of Professor Massey as has been written was given in his own words on October 11, 1921. He was writing to a Progressive Farmer reader who had written to congratulate him on entering his eighty-third year and had asked Professor Massey for some reminiscences of his life. Professor Massey answered:

"I did not start in life as a farmer. I had a scientific education and started out as a civil engineer and before I was twenty-one I had tramped the country west of the Mississippi, running railroad lines from Minnesota to Texas. The Civil War stopped this, and I wore a gray uniform for a time. But I had seen the opening of the prairies and the fearful waste that was entering on the virgin soils. Men threw their manure into streams and ponds to get rid of it and laughed at the idea that the soils of the Mississippi would ever need it. Today the great fertilizer factories in the West attest the waste of former days.

"Seeing all this waste, I determined to devote my life to a close study of the soil and its improvement. From 1865 to 1885 I call my 'undergraduate course' for I was hard at work farming and gardening for a while under glass. Sometimes I had a run of good returns and then panics and the failure of those I had invested money in helping threw me back. But my idea was to learn so that I might teach and help others.

"In 1885 I was asked to inaugurate an agricultural department in the highly endowed Miller School of Albemarle, Va. Then I felt that I had received my diploma as a farmer, as men seemed to appreciate what I had done in that line. I undertook the work in Virginia, including the improvement of 1200 acres of hill and dale as a stock farm and to teach practical farming and gardening to the boys. Teaching farming at that time was simply telling the boys one's own experience, for there were no textbooks worth using.

"I must have made some reputation in the few years I spent at the Miller school, for in three years I was invited to take the chair of agriculture in the Virginia Polytechnic Institute at Blacksburg, but declined. The next summer they renewed the offer and again I declined. In the meantime a committee of three men from Raleigh visited the Miller school and stated that they were contemplating starting a farm school in Raleigh. They seemed very much interested in going over the farm and noting what I was doing. Then the next year I received a letter from the Board of Trustees of the North Carolina College of Agriculture and Mechanic Arts asking me to take the chair of botany and horticulture and the office of the horticulturist of the experiment station, as they had made arrangements for the chair of agriculture. Believing that a wider field was opening for me, I accepted at an actual sacrifice in pay.

"Then my work opened up for me. I found there was little interest in soil improvement and I started in to try to arouse the farmers to the value of legumes for soil improvement, especially the familiar cowpea . . . . I have always tried to keep the moral and spiritual idea before the farmers, dwelling on the responsibility of the farmer as God's tenant for the condition of the soil he cultivates. 'The earth is the Lord's and the fullness thereof!' Therefore if a farmer runs down his soil and brings to God only the leanness instead of the fullness, he is responsible for his life work. My morning prayer for forty years has been that I might that day help someone to a better use of God's soil. When once a man realizes that he is not sole owner of the land but that he is the tenant of Him who owns all, he will be a better farmer and will take a new interest in the improvement and will not wrap his talent in a napkin.

"I have just passed my eighty-second birthday and may never pass another here, but I expect to the last to work for the improvement of the Southern farmer and Southern farms."

HORTICULTURAL DEVELOPMENT IN NORTH CAROLINA

North Carolina possesses economic and natural advantages for the production of horticultural crops that are equalled by but few states. Agricultural conditions in the State which include the general economic need for diversification, boll weevil conditions, and the realization of the advantages for different horticultural crops has been largely responsible for causing North Carolina to grow very rapidly in horticulture, with a number of horticultural industries, and the greatest interest in both commercial and home horticulture that has ever existed in the State. The following table indicates the rapid development that has been made.

Total Number of Cars of Fruits and Vegetables Shipped

1920	1921	1922	1923	1924	1925	1926
6,484	8,149	9,797	11,260	16,237	15,421	17,217

In the following table is given the number of cars of the more important fruits and vegetables shipped during 1926:

Apples	393	Cabbage	347
Peaches	2,155	Cucumbers	869
Strawberries	1,253	Lettuce	540
Dewberries		Mixed vegetables	673
Watermelons	1,301	Peas	596
Cantaloupes	397	Sweet potatoes	1,364
String beans	550	Irish potatoes	6,713

While the station does not claim credit for this rapid expansion, the activities of the station are reflected in the growth of the horticultural industries.

Need of Research and Opportunity for Service. The tremendous growth of our horticultural industries together with the wide range of natural conditions has created many urgent problems in connection with the production, handling, and marketing of horticultural crops, and has resulted in the largest demand ever made on the department for research work.

Developing an Enlarged Program of Horticultural Research. To meet the increased demand for research work the horticultural group of the station has spent much time in reorganizing its program of research, both to include the problems which have arisen following the rapid development of horticulture in the State and to conduct investigations with different crops in different sections of the State.

In developing its research program, the horticultural group, by the survey method has made an effort to determine the most important problems in horticulture for this State, so that a horticultural research program will be developed to give the maximum amount of service. A very careful study of the horticultural crops and possibilities of the State has been made to determine the most important industries and the most important problems.

PROGRESS REPORT ON PROJECTS

Strawberry Variety Test. The object of this work is to determine which varieties of strawberries are the best for the Mountain section of North Carolina.

In the spring of 1927 plats of the following varieties were set out at the Mountain Branch station:

Premier	William Belt
Klondike	Gandy
Missionary	Steven's Lake Champion
Senator Dunlap	Nick Ohmer
Big Joe	Dr. Burrell
Sample	Brandywine
McAlpin	Excelsior
Big Late	Aroma
Chesapeake	Warfield

The old planting was completely killed out by adverse seasonal conditions last year, consequently no results were secured this year.

Strawberry Fertilizer Investigations. Investigations were started in April, 1926, in co-operation with the Division of Agronomy at the Lower Coastal Plain station to determine the best fertilizers for strawberries from the standpoint of quality and yield, best sources of the different fertilizing materials to use, best time and method of fertilizer application, and the effect upon size, color, and carrying quality of fruit.

Thirty-four plats were laid out using varying percentages of the different fertilizer elements and using various materials as sources of plant food. One-half of each plat was limed and one-half left unlimed. The matted row system was followed. Owing to the difficulty in obtaining a stand, the percentage of stand was estimated for each plat before picking began and this was used as a factor in computing yields. The Missionary variety was used for this experiment. Yields were recorded by weight for each plat. Four times during the season an average cup of berries was counted and the number per pound computed. Two shipments were made to Raleigh during the season to compare the carrying quality of the berries from each plat.

Owing to an extremely dry spring which hurt the berry plants considerably and dried up the berries before they ripened, the results for this season are not conclusive. One of the outstanding features, however, was that the unlimed plats outyielded the limed plats in almost every case. Also, there were more berries per pound from the limed plats than from the unlimed plats showing that the berries were smaller. The check plats which had no fertilizer and the guard rows ripened their berries earlier than the fertilized plats. Color differences were not discernible. Practically no difference in carrying quality was noticed.

Summer Apples. The object of this work is to determine the most desirable varieties of summer apples for eastern North Carolina.

Trees of a number of standard summer varieties were planted at the Lower Coastal Plain station in 1913. Notes, observations and yields on the general production of the orchard and on the production of individual varieties have been made each year.

Yield of Summer Apple—Lower Coastal Plain Branch Station, 1926

Variety	No. of Trees	Average Yield Bushel	Date Fully Ripe	Remarks
Yellow Transparent	3	1.94	June 30	Very good
Early Ripe	1	1.	July 4	Small
Red Astrachan	2	2.5	July 2	Very good
Sweet Bough	1	3.	July 1	Poor
Red June	7	.33	July 8	Small
Chenango	3	1.34	July 6	Good
Williams E. Red	6	1.33	July 10	Very good
Early Harvest	9	2.66	July 6	Very good
Liveland Raspberry	7	2.00	July 12	Very good
Starr	7	.77	July 15	Sour-poor
Early Colton	7	.84	June 25	Good-large
Eckels' Sweet Red June	3	3.00	July 17	Good sweet apple

Five-year-old Stayman tree lightly pruned. Note size of tree. Other trees of same age, heavily pruned, produced no fruit.

Of the varieties tested during the period of the investigation, Liveland Raspberry, Williams, Eckels Sweet Red June, Red Astrachan, Early Harvest, and Yellow Transparent gave the best results. The last three varieties are much troubled with blight which lessens their value. Where

local markets exist or where rail facilities are good, the production of summer apples in Eastern North Carolina will prove profitable.

Training and Pruning Apple Trees. Apple training and pruning investigations were started at the Mountain station in 1919 and at the Piedmont station in 1924, to determine the relation of the amount of annual pruning to early bearing and productiveness.

Investigations have been conducted at the Mountain station since 1919, to determine the comparative value of the open head and the modified leader systems of training and to determine the comparative value of the low headed and high headed tree.

The orchard at the Mountain station was divided into blocks in which open head and modified leader systems of training have been followed and in which heavy, medium and light pruning has been practiced. Measurements of annual growth of each tree have been secured and recorded. Crop records have been secured.

The following tables supply information on the effect of different degrees of pruning on size of trees and on early bearing and on yield.

Effect of Heavy and Light Pruning in Relation to Size of Apple Trees

Variety	Age	Heavy Pruned		Light Pruned	
		No. of Trees	Diameter of Trunk	No. of Trees	Diameter of Trunk
Rome	8	11	2.73 in.	7	3.21 in.
Winesap	8	10	3.52 in.	8	4.43 in.
Stayman	8	10	3.92 in.	7	4.36 in.
Delicious	8	11	3.26 in.	8	3.83 in.

Effect of Heavy, Medium, and Light Pruning in Relation to Early Bearing and Yield

Variety	Age	Heavy Pruned		Medium Pruned		Light Pruned	
		No. of Trees	Yield in Bushels	No. of Trees	Yield in Bushels	No. of Trees	Yield in Bushels
Rome	8	11	.31	8	.69	8	1.41
Winesap	8	11	1.17	8	3.52	8	4.01
Stayman	8	11	2.22	8	4.75	8	6.56
Delicious	8	11	.18	8	.74	8	1.98

These results show that lightly pruned trees are larger, come into bearing earlier, and produce more fruit than those pruned heavily.

Apple Fertilization. Apple fertilization investigations were started at the Mountain station in 1924, to determine the effects of different elements alone and in combination on growth and production.

One hundred and sixteen one-year-old apple whips were planted in 1924, half being of the Bonum variety and the remainder Delicious. This planting has been divided into fifteen plots each receiving a different treatment.

The trunk diameters of each tree have been secured each year. The following table gives results for the current year.

Effect of Different Fertilizer Treatments

Plot No.	Treatment	No. of Trees	Aver. Diam. of Trunk Inches
1	Stable manure	4	2.10
2	N	8	2.28
3	P	8	2.18
4	K	8	2.09
5	NP	8	1.79
6	NK	8	2.18
7	PK	8	2.03
8	NPK	8	2.15
9	Check	12	1.83
10	2 N	8	1.88
11	2 P	8	1.94
12	2 K	8	1.77
13	2 NPK	8	1.95
14	Lime	8	1.98
15	Lime NPK	4	2.08

Tendencies are indicated but no well defined differences are apparent. The work has not been conducted a sufficient length of time to supply definite results.

Apple Storage. Apple storage investigations to determine the best methods of operating an air cooled storage house were started in the new apple storage house at the Mountain station in 1926.

A hygrothermograph was operated in the house to secure temperature and humidity records.

Fruit was stored in both bins and crates. The work has not been conducted a sufficient length of time to supply definite results but the value of such a house in Western North Carolina is indicated by the manner in which the crop was kept.

Peach Breeding. This work was originally started in 1917, at the Lower Coastal Plain station for the purpose of producing both earlier varieties and hardier varieties but conditions in that location were unfavorable and it was decided to transfer the work to the sandhills.

Trees of the different varieties have been propagated and will be set out this fall.

Hardiness of Peach Varieties for Western North Carolina. Peach trees in the mountains, even in those sections where the altitude does not exceed 2200 feet, are very often killed in the winter.

This work is being conducted for the purpose of comparing those varieties that withstand low temperatures in the North with Southern varieties as regards resistance to cold in the mountains, and to determine if any of the hardier Northern varieties will be better adapted to mountain conditions than the varieties now being grown.

Twenty varieties of peaches comprising varieties adapted both to extreme Northern and extreme Southern conditions were planted in 1919, to furnish material for this project.

Data collected to date indicate that there is very little difference in Northern and Southern varieties as regards hardiness of buds, but that the Northern varieties of Crosby, Engle, and Kalamazoo are outstanding as regards hardiness of trees.

Peach Fertilization. It is intended to make this project cover the investigation of the response of peach trees to different fertilizer elements when used alone and in combination.

However, the work that is in progress has been started in response to inquiries regarding the use of readily available mineral nitrogen with peach trees and has been conducted to determine the value of applying nitrate of soda before blooming in relation to yield and quality of fruit.

Average Yield of Trees With and Without Nitrate of Soda—Piedmont Station. 3-Year-Old Trees, Fourth Summer

Variety	Average Yield per Tree	
	1 lb. Nitrate of Soda per Tree	No Nitrate
Hiley	1.3 bu.	.35 bu.
Georgia Belle	1.6 bu.	.40 bu.
Elberta	.76 bu.	.50 bu.
J. H. Hale	1.2 bu.	.87 bu.
Augbert	.42 bu.	.20 bu.

Yield was increased but color was reduced in some instances due to dense foliage.

The trees receiving the annual applications of nitrate were larger than those receiving no nitrate.

Peach Pruning. Experiments were started in 1924 at the Piedmont station to determine the effects of heavy and light pruning on yield of peach trees.

Three hundred seventeen trees of five varieties were planted in 1923, to supply material for this work. These trees were trained to the open head system and annually one lot was pruned heavily with much cutting back while the other lot was lightly pruned, the pruning consisting mainly of thinning out with very little heading back. Uniform orchard management was given throughout the orchard. Records of growth and yield are taken.

Comparison of Heavy and Light Pruning in Relation to Bearing

Variety	Age	Heavy Pruned		Light Pruned	
		No. of Trees	Average Yield bushels	No. of Trees	Average Yield bushels
Hiley	4	51	.24	30	1.03
Belle	4	52	.46	28	1.64
Elberta	4	55	.38	25	.76
Hale	4	26	.50	15	1.20
Augbert	4	22	.16	13	.42

Lightly pruned trees are larger and produce larger crops than trees heavily pruned.

Peach Winterkilling. Because of severe losses of trees in the sandhill section projects have been formulated to determine the nature, and causes of winter injury and to formulate a method of preventing it.

The study is based on the condition of the tree which makes it susceptible or resistant to winterkilling. Blocks of trees have been estab-

lished in different orchards through the peach section under the following cultural conditions:

1. Low vigor throughout the year.
2. High vigor throughout the year.
3. High vigor in early season, hardened off or low vigor after harvest.
4. Normal archard practice.

The following studies are being made:

1. Amount and character of growth.
2. Nature and time of maturity, dormancy, rest period.
3. Nature and type of winter injury.
4. Food storage and carbohydrate-nitrogen relation.
5. Catalaze activity.
6. Sap concentration.
7. Conditions under which injury is produced.

During the past year, data has been collected on trunk diameter, twig growth, color of foliage, and time of fruit bud differentiation and defoliation.

Samples have been collected for laboratory study and are being analyzed at the present time.

Measurements of twigs on May 1st, has shown that trees in high vigor have a greater initial growth in the spring indicative of better food storage and high sap concentration during the previous season for carrying trees through the winter. Uniform samples of leaves were extracted in alcohol and the absorption spectra determined on a spectrascope with an arbitrary scale to determine actual differences in chlorophyle content. The following table shows this data for one orchard.

Treatment	Length of Shoot Growth May 1, 1927 inches	Average Weight Shoots April 15, 1927 grams	Absorption Spectra Arbitrary Scale
No extra nitrate	.89	.07	5.9 - 10.1
2 lbs. nitrate July 1, 1926	2.02	0.14	6.05- 9.7
2 lbs. nitrate July 1 and Aug. 15, 1926	3.96	0.26	6.1 - 9.7

No conclusions can be drawn at this time, but data suggests that healthy vigor throughout the year by the application of extra nitrogen fertilizer, gives greater food storage and higher sap concentration during the dormant season, greater initial vigor in spring, better set of fruit buds, and later defoliation in fall.

Variety Testing of Pecans. Investigations to determine the most satisfactory varieties of pecans for North Carolina, and to determine the commercial limitations of pecan production in this State were started in 1906, when plantings were made at the Lower Coastal Plain Station, Willard, N. C.; Upper Coastal Plain Station, Kingsboro, N. C.; Piedmont Station, Statesville, N. C.; and the Mountain Station, Swannanoa, N. C.

Thirty-two of the most important Southern varieties were included in this project. Yield, growth, and quality records have been secured each year.

Results to date indicate the desirability of confining commercial plantings of pecans to the Coastal Plain section and the Lower Piedmont.

The Stuart and Schley varieties have proved the most desirable from the standpoint of yield and quality.

The results show that pecan trees grow slowly and produce very few nuts in the Mountain and Upper Piedmont sections.

Pecan Breeding. This project was started in 1912, with the object of developing improved varieties and varieties especially suited to North Carolina conditions.

Over four hundred seedling trees from the best varieties (the male parent being unknown) were planted. In addition nearly one hundred seedlings, the progeny of known crosses of best varieties were planted.

These seedlings are closely observed and a study made of the nuts produced. At the present time nearly fifty of the seedlings have been discarded as worthless. Several appear to be promising and will be given further consideration.

Cracking Tests with Pecans. The cracking quality of a variety is an important fact in determining its value.

With the object of determining the value of different varieties as regards cracking quality, investigations were begun in 1915. Annually one pound of nuts of each variety is counted and cracked. The number of nuts to the pound, number of whole halves secured, number of wrinkled halves, number of worthless nuts, and similar information is recorded.

The Schley and Alley varieties rank highest in cracking quality.

Annual and Alternate Bearing of Pecans. In February, 1927, investigations dealing with the relation of orchard management to annual and alternate bearing of pecans and the relation of fruit bud formation to annual and alternate bearing of pecans were started at the Upper Coastal Plain Station.

In the first line of investigation, clean cultivation—no cover crop, clean cultivation—rye and vetch cover crop, and sod culture are the systems of orchard management compared in their relation to annual and alternate bearing.

In the second line of investigation measurements of annual growth and analysis of pecan fruiting and non-fruiting wood are made to determine the relationship between vigor and food storage on the one hand, and blossom bud formation on the other.

This work has not been conducted a sufficient length of time to supply results.

Vitis Rotundifolia—Inheritance of Characters. This work in various forms has been carried on since about 1908. The object has been to study the inheritance of such characters as size, sex, cluster, quality, etc., as already reported. The active breeding has been discontinued to bring the project to a close.

The best and most promising seedlings (most of which are self-fertile) of these various crosses have been selected and are being propagated as rapidly as possible for distribution. These will be carefully described and photographed as it is believed that they will have a valuable place among fruit varieties.

In regard to size of clusters it would seem that cultural practices have

as much or more effect than inheritance, although a self-fertile vine tends to set larger and less compact clusters.

The lack of cling quality of the berries is not entirely a bad character as berries that shatter easily present a more attractive appearance than those on which the skin tears by the partial adherence to the pedicel.

Vitis Rotundifolia—Hybridization with Other Species. The object of this project has been to study the inheritance of characters in these crosses and in order to determine methods of hybridization to combine the best characters of each species.

Originally it was hoped that a valuable combination of the characters might be effected between this species and bunch grapes. The desire was to retain the season of ripening, the disease resistance and the distinctive qualities of the muscadine and combine them with the cluster type and thin skin of the bunch grape.

Direct and reciprocal crosses have been tried with V. rotundifolia and several of the species of bunch grapes as previously reported. As the resulting hybrids have been almost uniformly sterile and hybridization was difficult to effect active breeding work has been discontinued to bring the project to a close.

During the past season a few single seeded fruits of a Malaga x V. rotundifolia cross were set. These were of excellent quality but very small. The seed has been saved and attempts will be made to secure an F_2 generation from them.

Storage of First Crop Irish Potatoes in Sweet Potato Storage House. Investigations were started in 1921 to determine the value of sweet potato storage houses for storing first crop Irish potatoes during the summer.

Potatoes of the Irish Cobbler variety are harvested during the regular potato season and placed in the sweet potato storage house for summer storage. In the fall these potatoes are examined and condition noted.

On June 29th, four crates of potatoes were harvested and placed in the sweet potato storage house. On September 10th they were removed from storage and examined. There was a 1.2% loss from decay. The sound potatoes were smooth, firm and just beginning to show sprouts.

The results of this year confirm previous work to the effect that the sweet potato storage houses in Eastern North Carolina can be successfully used to keep Irish potatoes of the early crop through the summer.

Value of Irish Potato Seed from Different Sources. Experiments were started in 1920 at the Lower Coastal Plain Station to compare Irish potato seed from different sources for use in Eastern North Carolina, especially Western North Carolina seed with Northern seed.

This year Western North Carolina seed was obtained from the Mountain Station and the Northern seed was grown in Maine. The plats were handled alike throughout the season.

The results for the year show a much greater yield from the Maine seed than from the North Carolina seed. These results are contrary to the results of previous years. However, it may be explained by the fact that we have always obtained our seed from the higher elevations of Avery and Watauga counties while this year the seed was grown at the Mountain Station which is of relatively low altitude.

Effect of Cultural Practices on Yield of Irish Potatoes

1. Comparison of Different Spacings on Yield.

The purpose of this experiment is to determine the effect of spacing on the yield of Irish potatoes.

A two-ounce seed piece was used in this work with the rows three feet apart, the seed pieces were planted 9 inches, 12 inches, 15 inches and 18 inches apart respectively. With the seed pieces 15 inches apart in the row, a comparison was also made by spacing the rows 2½ feet, 3 feet, 3½ feet and 4 feet apart respectively. The accompanying tables give detailed results for this year.

Effect of Cultural Practices Different Distances in the Row

Planted March 23, 1927
Harvested June 22, 1927 Lower Coastal Plain Branch Station, 1927
Variety: Irish Cobbler

Plot	Area (acres)	Yield Per Acre (bushels)		Total Yield per Acre (bushels)
		No. 1	No. 2	
3'x12"	1/69.15	233.38	38.61	271.99
3'x15"	1/69.15	237.42	33.42	270.84
3'x18"	1/69.15	195.33	26.51	221.86
3'x9"	1/69.15	217.82	54.17	271.99
2½'x9"	1/83	245.54	49.80	295.34
2½'x12"	1/83	208.19	48.42	256.61
2½'x15"	1/83	211.64	62.25	273.89
4'x9"	1/51.86	187.55	33.71	221.26
4'x15"	1/51.86	191.87	37.16	229.03
3½'x15"	1/59.27	228.68	39.51	268.19
4'x15"	1/51.86	191.87	37.16	229.03
2½'x15"	1/83	211.64	62.25	273.89
3'x15"	1/69.15	237.42	33.42	270.84

Note: Very dry season.
60 lbs. 1 bushel.

As in previous years the closer spacing gave higher yields but this season the differences were not so marked. The unusually dry spring reduced the yields in the closely spaced plats.

2. Comparison of Cut Seed and Whole Seed of Irish Potatoes.

The purpose of this experiment is to determine whether whole seed or cut seed will give better yields.

Two ounce seed pieces were planted 15 inches apart in rows three feet

apart in adjoining plats. The plats were harvested at the same time and yields recorded by weight.

Cut Seed vs. Whole Seed

Planted March 23, 1927
Harvested June 22, 1927 Lower Coastal Plain Branch Station, 1927
Variety: Irish Cobbler

Plot	Area	Yield per Acre (bu.)		Total Yield per Acre (bushels)
		No. 1	No. 2	
Cut seed	1/116	177.14	38.72	215.86
Whole seed	1/116	266.20	25.17	291.37

60 lbs. 1 bushel.

The results this year are strongly in favor of the whole seed. In previous years, however, this has not always been true and a general average would show little difference between cut and whole seed.

Effect of Cultural Practices on the Yield of Sweet Potatoes

Investigations to determine the effect of spacing on the yield of sweet potatoes were started at the Coastal Plain stations in 1919. This year the work was done at the Lower Coastal Plain Station. Plants were set 12 inches, 18 inches and 24 inches apart in the row respectively, with rows 3½ feet apart. Plats were handled alike throughout the season. The accompanying tables give the year's results.

Effect of Planting Distance on Yield

Planted June 11, 1926
Harvested October 26, 1926 Upper Coastal Plain Branch Station, 1926
Variety: Porto Rico

Plot	Yield per Acre (bu.)			Total Yield per Acre (bushels)
	No. 1	Jumbo	Culls	
14-24a 12" apart	71.40	1.43	25.35	98.18
14-24b 18" apart	72.11	00	14.99	87.10
14-24c 24" apart	57.83	.71	14.99	73.53

Rows 3½ ft. apart.
Plots 1/20 acre.
56 lbs. 1 bushel.

Effect of Planting Distance on Yield

Planted June 8, 1926
Harvested October 20, 1926 Lower Coastal Plain Branch Station, 1926
Variety: Porto Rico

Plat	Yield per Acre (bu.)			Total Yield per Acre (bushels)
	No. 1	Jumbo	Culls	
14-24a 12" apart	162.44	111.38	11.78	285.60
24-24b 18" apart	119.24	79.61	13.21	212.06
14-24c 24" apart	106.39	84.25	9.28	199.91

Plats 1/40 acre.
Rows 3½ feet apart.
56 lbs. 1 bushel.

The twelve-inch spacing gave a much higher yield per acre of marketable tubers at the Lower Coastal Plain Station, but gave practically the same yield at the eighteen-inch spacing at the Upper Coastal Plain Station. This was probably due to the severe drought.

Four years' work greatly favors the close spacing. In years with plenty of rainfall even closer spacing than twelve inches would probably be profitable but in dry seasons close spacing would be detrimental under some soil conditions.

Sweet Potato Storage. Storage investigations with sweet potatoes have been in progress since 1916 and are conducted at the Lower Coastal Plain Station and the Upper Coastal Plain Station.

The purpose of these experiments is to determine the effect of frost, maturity and time of harvest on the keeping quality of sweet potatoes in storage.

Beginning about October 1, potatoes were harvested at short intervals, and each lot was cured separately and placed in storage. The last digging was timed to take place at least two weeks after a hard frost. In March the different lots of potatoes were removed from storage and records taken of the loss during storage.

Effect of Frost and Maturity on Keeping Quality

Planted June 10, 1926 Upper Coastal Plain Branch Station
Variety: Porto Rico 1926-1927

Harvested	Number Potatoes	Number Sound	Number Decayed	Per Cent. Sound	Per Cent. Decayed	Remarks
9-30-26	261	231	30	88.51	11.49	
10-15-26	250	221	29	88.40	11.60	
10-26-26	194	179	15	92.27	7.73	
11-26-26	163	88	75	53.99	46.01	First killing frost about Nov. 1

Stored until March 17, 1927.

Effect of Frost and Maturity on Keeping Quality

Planted June 8, 1926
Variety: Porto Rico

Lower Coastal Plain Branch Station
1926-1927

Harvested	Number Potatoes	Number Sound	Number Decayed	Per Cent. Sound	Per Cent. Decayed
9-28-26	260	251	9	96.54	3.46
10-12-26	313	304	9	97.12	2.88
10-21-26	254	252	2	99.21	.79
11-16-26	180	106	74	58.89	41.11

Taken from storage March 23, 1927.
Killing frost about November 1.

Very conclusive results were obtained this year showing the heavy loss in storage due to late digging. The results also show that although immature potatoes do not keep so well as mature potatoes, the loss from digging too early is small as compared with the loss from cold.

Large vs. Small Sweet Potatoes for Seed Purposes. Investigations dealing with seed selection with sweet potatoes were started in 1920.

An experiment to determine whether large or small sweet potatoes are better for seed purposes was started at the Coastal Plain Station this year.

Potatoes of a large, No. 1 grade, and potatoes below the size of No. 2 grade were selected from the same stock and bedded separately. Plants were set in separate plats in the field under similar conditions. At harvest yields were recorded by weight.

Large vs. Small Potatoes for Seed

Planted June 11, 1926
Harvested October 26, 1926
Variety: Porto Rico

Upper Coastal Plain Branch Station, 1926

Plot	Yield per Acre (bushel)			Total Yield per Acre (bushel)
	No. 1	Jumbo	Culls	
Large Seed	81.47	00	29.99	111.46
Small Seed	81.47	00	33.20	114.67

Planted June 8, 1926
Harvested October 20, 1926
Variety: Nancy Hall

Lower Coastal Plain Station, 1926

Large Seed	168.50	00	28.56	197.06
Small Seed	174.22	00	16.42	190.64

Plots 1/80 acre.
Rows 3½ ft. apart; plants 12" apart in row.
56 lbs. 1 bu.

Results at both the Upper and Lower Coastal Plain stations seem to indicate that there is practically no difference in yield of No. 1 potatoes from the use of small or large seed.

Sweet Potato Fertilizer Tests. Sweet potato fertilizer investigations were started at the Coastal Plain stations in 1925.

The purpose of these experiments were to determine whether or not increased yields may be secured by using higher percentages of potash and whether or not muriate or sulphate of potash should be used; and also to determine the comparative value of mineral or organic nitrogen.

The fertilizer was applied in the ridge at the rate of 600 pounds per acre before planting. The phosphorous is derived from acid phosphate, one-third of the nitrogen from nitrate of soda, two-thirds of the nitrogen from animal tankage except where otherwise noted in the tables, and the potash was derived from muriate of potash except where otherwise noted.

Sweet Potato Fertilizer Test

Planted June 10, 1926
Harvested October 25, 1926 Upper Coastal Plain Branch Station, 1926
Variety: Nancy Hall

Plat No.	Fertilizer P-N-K	Yield per Acre (bushels)			Total Yield per Acre (bu.)
		No. 1	Jumbo	Cull	
1	8-3-4	93.40	1.42	44.44	139.26
2	8-3-6	90.68	.....	35.88	116.56
3	8-3-6 Nitrate of Soda	129.28	.....	41.77	171.05
4	8-3-6 Tankage	79.61	.....	47.84	127.45
5	8-3-6 Sulphate of Ammonia	114.78	.....	39.80	154.58
6	8-3-8	126.02	.....	54.80	180.82
7	8-3-10	115.17	.....	38.20	153.37
8	8-3-6 Muriate 8-3-6	99.96	.....	39.98	139.94
9	Sulphate of Potash	83.72	.....	40.70	124.42
10	No fertilizer	39.45	.....	31.06	70.51

Plats 1/20 acre.
Rate of application 600 lbs. per acre.

Sweet Potato Fertilizer Test

Planted June 7, 1926
Harvested October 19, 1926 Lower Coastal Plain Branch Station, 1926
Variety: Porto Rico

Plat No.	Fertilizer P-N-K	Yield per Acre (bushels)			Total Yield per Acre (bu.)
		No. 1	Jumbo	Cull	
1	8-3-4	232.84	88.54	18.21	339.59
2	8-3-6	231.34	80.68	15.71	327.73
3	8-3-6 Nitrate of Soda	252.40	83.18	18.21	353.79
4	8-3-6 Tankage	187.07	111.38	13.92	312.37
5	8-3-6 Sulphate of Ammonia	239.55	103.17	11.07	353.79
6	8-3-8	156.72	117.10	13.21	287.03
7	8-3-10	216.34	94.25	18.56	329.15
8	8-3-6 Muriate of Potash	165.65	125.66	16.42	307.73
9	8-3-6 Sulphate of Potash	203.92	96.03	17.49	317.44
10	No fertilizer	185.28	93.18	13.57	292.03

Plats 1/40 acre.
Rate of application 600 lbs. per acre.

This is the second year of the experiment and results are very similar to those of last year. The season was again very dry. The mineral nitrates gave better yields than organic nitrates when used as the sole source of nitrogen. High percentage of potash gave increased yields at the Upper Coastal Plain Station but was not outstanding at the Lower Coastal Plain Station.

No definite conclusions can be formed until we have a season of normal rainfall.

Lettuce Investigations. 1. Investigations were begun at the Lower Coastal Plain Station in January, 1926, to determine the conditions which cause tip burn of lettuce.

Except in the case of special treatments the lettuce plots were handled exactly as the crop is handled under field conditions. Plants were set twelve inches apart on two-row, raised beds. The Big Boston variety was used. Fertilizer analyzing 7-5-7 (P-N-K) had previously been applied at the rate of 2000 pounds per acre on all plats except three, on one of which nitrate of soda was used as the source of N, on one sulphate of

ammonia was used as the source of N, and on one basic slag was used as the source of phosphorus instead of acid phosphate. Just before the lettuce commenced to form heads, one plat was provided with a burlap cover to shield the lettuce from the sun; one plat was shielded from the wind with boards stood on edge; one plat was irrigated daily by means of a furrow between the rows; one plat was sprayed with Bordeaux mixture; one plat was sprayed with lime water. The sprays were applied once a week which was sufficient to keep the leaves covered since there was very little rain during the lettuce season. Atmometer, anamometer, and maximum-minimum temperature readings were taken daily, morning and night. A hygrothermograph was used to record the daily humidity. When the lettuce began to head, daily counts were made of the heads which showed evidences of tipburn.

As was noted last year, tipburn was more severe under shade than out in the open. Spraying with Bordeaux mixture and lime water gave no control. Ammonium sulphate seemed to have a detrimental effect on the lettuce plant growth. Basic slag and nitrate of soda showed no outstanding effects.

Tip burn seemed to show up more noticeably when a light rain was followed by a hot day with humid atmospheric conditions.

Although tip burn was very severe on the experimental plats, it was noted that most of the early formed heads did not burn until a few days after they had reached the cutting state. Also many of the later heads could have been marketed before they had burned. Therefore an alert grower could prevent much of the loss from tip burn by early cutting.

2. Work was started in 1926 at the Lower Coastal Plain station and in the Wilmington lettuce section to discover or develop a strain of the Iceberg type of lettuce which will consistently form solid heads in Eastern North Carolina.

Last season twenty-five strains and stock of seed of the New York and Iceberg varieties were obtained from the best seed growers in this country. These were planted at Wilmington. Of these the four best strains were selected and again planted this year. At the same time about thirty pounds of seed of the best of these strains was brought and planted by the growers. This season approximately 85 per cent. of solid heads were obtained from this strain.

As a result the growers have purchased over 200 pounds of seed of this strain of New York lettuce for next year's crop.

3. Selection work with Big Boston lettuce was started in 1926 with the object of securing a strain of Big Boston lettuce resistant to tip burn.

Last season twenty-five heads of Big Boston lettuce in the experimental plots which did not show evidences of tip burn were allowed to produce seed. The seed from each head was planted separately this year in the trial grounds. This season fifty heads were selected and seed saved for planting next year.

Practically all the heads produced from the seed saved last year showed tip burn this year. However, no definite conclusions may be drawn from these results.

Dewberry Investigations. Investigations dealing with a physiological study of dewberry plants was started in 1925.

The work is divided into three parts:

1. Effect of times and amounts of fertilizer application.
2. Effect of pruning methods.
3. Food storage.

The three fertilizer elements (N.P.K.) have been applied alone and in combination so that the effect of the presence and lack of each one on the plant may be studied, and from this basis fertilizer data secured.

Two methods of pruning are being tried, namely, the common practice of cutting off all growth after harvest, and leaving spring canes for bearing the following year's crop.

Samples are being collected for laboratory analysis.

This work has been in effect only two years with only one season's growth and crop effected. The dry season of 1926 made a very light cane growth, and the prevalence of disease made it necessary to cut off the spring canes that had been left for fruiting. This later phase of the work will have to be conducted at the Central station.

The following tables present some of the data collected for one year under adverse conditions.

Dewberry

Treatment	Yields		Growth			Firmness		
	Av. of 10 Plants quarts		Average Number Fruit Canes 6-1-27	Average Length Spring Canes 6-15-27 Inches	Average Number Spring Canes 6-15-27	Average Per Cent Soft Berries		
	Plat 1	Plat 2				6-12-27	6-15-27	Average
N	11.91	10.58	2.17	40.78	6.8	5.7	7.8	6.7
P	10.91	10.16	2.37	30.61	6.6	5.2	1.7	3.5
K	10.37	10.74	1.62	36.89	6.9	5.7	2.9	4.3
NP	10.75	11.41	2.4	41.29	8.4	4.5	7.5	6.0
NK	11.00	11.40	1.65	40.39	8.7	3.2	5.8	4.5
PK	9.91	9.50	1.90	33.08	9.8	3.5	2.4	3.9
NPK	10.00	10.57	2.1	39.63	8.6	5.0	3.5	4.2
NPK—all N applied after harvest	11.83	11.99	1.65	37.93	7.7	1.1	1.9	2.5

It is too early to draw any conclusions. However, it would seem that the data indicated the following tendencies.

Yields. As the average of all treatments with nitrate gave an average yield of 11.14 quarts against 10.26 for treatments without nitrate, and as these differences are greater than with other treatments, the nitrogen carrying part of the fertilizer is more important than the others. However, potash apparently reduced the number of soft berries, and nitrate in the spring increases it. Also that most of the ammonia fertilizer should be applied after harvest and after the canes are cut off in July.

In regard to pruning, the difficulties of leaving spring canes and removing mature wood, and the control of disease would necessitate a change in cultural practices or a great increase in crop returns to be practical.

Genetical Study of Genus Rubus—Especially Raspberries. The purpose of this project is to develop a more satisfactory raspberry for this sec-

tion. Except for the Mountain section all raspberries are very short lived if they grow at all.

The plan is to determine the limiting factors to discover what species will grow satisfactorily and by breeding, to develop a variety that will prove satisfactory. One of the big difficulties has been to establish a planting that would survive long enough for any study and breeding work. In 1926, G. M. Darrow offered the facilities of Bell Station, Maryland, with their collection of species and varieties which were unavailable anywhere else. The offer was accepted in 1926.

The seed of the 1926 crosses have been grown in plats and pots and will be moved to the fields this coming year.

The work has not been carried on a sufficient time to draw any conclusions but the aptological studies of Langley and Darrow and the breeding work of Darrow at Bell Station, show the importance of confining crosses for fertile plants to the same chromosome groups. Some crosses were made in 1926, between groups of 7, 14, 21 and 28 chromosomes and will be studied from this viewpoint.

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POULTRY RESEARCH

The Poultry Research for the past year has consisted of studies with commercial poultry plant management costs; experiments in fattening poultry; the influence of meat meal vs. milk in growth, production and health of birds; a study of fish meal vs. meat meal in egg production; cost of putting pullets into lay; inheritance in egg production; study of septicaemic diseases; study of control of health of poultry; bacteriophage as applied to germ-borne diseases; normal hematology; the duration of the carrier stage of bacillary white diarrhea; pathological hematology; confirmation of the agglutination test for bacillary white diarrhea; soil pollution studies; study of contagious diseases of chicks; study of respiratory diseases; and an economic survey of poultry conditions in the city of Raleigh.

The 20' x 100' half-monitor commercial house in which the experimental studies were conducted. This house is located at the Mountain Branch Experimental Farm conducted jointly by the State Department of Agriculture and the North Carolina State College.

The research laboratories are located at State College, as is also the disease research plant and the central experimental poultry plant. Projects are also carried on at the Mountain Branch station, near Swannanoa, and at the Coastal Plain Branch station, near Willard, N. C., through the co-operation of the State Department of Agriculture, and at Sanitorium, N. C.

COMMERCIAL POULTRY PLANT MANAGEMENT COSTS

This project was conducted at the Mountain Branch Station. At the beginning of the year, November 1, 1925, there were in the commercial flock 750 laying Single Comb White Leghorns, of which 356, or 47%, were pullets and 394, or 43%, were hens. This flock was valued at $1,303.00. The cost for depreciation was $0.70 per bird, feed cost $2.047, for shell and grit $0.013, litter $0.012, labor—human $0.235, truck $0.014, buildings $0.257, land $0.010, water $0.001, equipment $0.025, interest on money invested in stock $0.117, interest on money invested in feed and supplies $0.026; miscellaneous costs $0.086, making a total cost per hen of $3.543. The cost of eggs equals the total cost less receipts from manure and miscellaneous—$2455.45 less $107.70 equals $2,347.75.

The returns were $3,960.48 for eggs and $368.00 for birds sold or eaten, making a total receipts of $4,328.48 or profit from the flock of $1,980.73.

The total cost of the flock operation was $2,347.75; cost per dozen eggs $0.243; cost per bird $3.54; total returns $4,328.48; returns per bird $5.94; profit per bird $2.40. The number pounds feed to produce a dozen eggs was 6.0; total number eggs produced 113,020; total number hen days 243,314; average production for the year 47.7 per cent.; average number hens 667; average number eggs per hen per year 170; average price of eggs $0.447.

There was consumed 26,154 pounds mash, or 39 pounds per bird, and 31,147 pounds grain, or 46.6 pounds per bird, making a total consumption of feed of 47,300 pounds, or 85.7 pounds per bird.

The North Carolina rations were used and are as follows: Mash—sodium chloride 1 lb., bone meal 4 lbs., fish meal 20 lbs., wheat middlings 20 lbs., pulverized oats 20 lbs., corn meal 35 lbs. Grain mixture—corn 50 lbs., oats 30 lbs., wheat 20 lbs.

The average costs of feeds per cwt. for the year were as follows: oats $1.96, corn $2.01, wheat $2.60, wheat middlings $1.88, ground oats $2.37, fish meal $3.52, bone meal $3.60, corn meal $2.26, salt $1.00.

EXPERIMENTS IN FATTENING POULTRY

In these tests April hatched Single Comb Rhode Island Red cockerels were used. To one-half of the batches equal parts of corn meal and pulverized oats were given and to the other half a mixture of 48 lbs. corn meal, 48 lbs. pulverized oats, and 4 lbs. limestone was given. The mash, at feeding time, was mixed with two pounds of buttermilk or soured skimmed milk to one pound of the mash mixture and the birds were given just what they would clean up in thirty minutes three times a day. The fattening period was ten days. The cockerels on going into the batteries were nine weeks old. In the first test Lot No. 1, receiving the pulverized limestone, made a gain of 38.7%, the feed cost being $0.157 per pound, and Lot No. 2, the control not receiving limestone, made a gain of 41.2 per cent. at a feed cost of $0.147 per pound. The finished birds brought $0.35 per pound on the market or a gain of $11.20 increased price as a result of the fattening at a feed cost of $4.80.

In the second test the limestone mash fed birds made a gain of 28.8 per cent. and the control birds 43.5 per cent. The control lot ate their

feed much better than the test lot. In the test the feed cost was $0.187 per pound gain and in the control $0.135. The feed cost of the 31.5 pounds gain was $4.92, leaving a net gain of $6.10 for fattening.

In the third test the limestone mash birds made a gain of 37 per cent. and the controls 40.4 per cent. The cost per pound gain of the limestone mash was $0.144 and of the controls $0.139. As in the other tests the lots making the greatest gain had the lowest feed cost. The feed cost of the 56.5 pounds gain was $6.98, leaving $12.89 for the fattening.

A fourth test was run, using meat meal as a substitute for milk. The ration consisted of 40 lbs. corn meal, 20 lbs. pulverized oats, 20 lbs. wheat middlings, and 20 lbs. meat meal. At feeding time this mixture was used by adding water until the feed was the consistency of batter, giving what the birds would clean up in thirty minutes three times a day. These two lots came out in fine condition and the feed cost per pound gain was only $0.0695 or approximately $0.07. One lot gained 43.8 per cent., the other 46.4 per cent. The fattening period was ten days. The chicks did not go off feed so easily on this meat meal ration as on the milk ration, especially in the very warm weather. The increased money received as a result of fattening was $25.72 with a feed cost of $5.10 or $20.62 for the process of fattening.

INFLUENCE OF MEAT MEAL AND MILK ON PRODUCTION AND HEALTH

The third year of a ten-year project will terminate October 31, 1927. A summary of artificial incubation for three hatches from each flock for the spring of 1927 is here given. Flock No. 1 has had meat meal three years as the sole source of their animal feed and flock No. 2 received only milk.

In the test for the influence of meat meal on the hatchability of eggs there were set 1476 eggs; 131 or 8.8% were infertile; 301 or 20.3% died in the shell and 1041 or 70.5% hatched. There were three eggs broken in the machine. There was 77.3% of the fertile eggs hatched.

In the test for the influence of milk on the hatchability of eggs 1468 eggs were set; 143 or 9.7% were infertile and 387 or 26.3% died in the shell; 931 or 63.4% hatched. There were 70.2% of the fertile eggs hatched.

FISH MEAL VS. MEAT MEAL IN EGG PRODUCTION

In the meat meal flock there was an average of 339 hens. The average annual production was 168 eggs per hen which was annual flock production of 46 per cent. It required 6.0 pounds of feed to produce a dozen eggs. The feed cost per dozen eggs was $0.145. The mash cost $2.58 and the grain $2.11 per cwt. The North Carolina ration was used with a feed cost per hen of $2.03.

In the fish meal flock there was an average of 338 hens. The average annual production was 166 eggs per hen. The annual flock production was 45.4%. The feed cost per dozen eggs was $0.149. It required 6.2 pounds feed to produce a dozen eggs. The mash cost $2.46 and the grain $2.11 per cwt. The feed cost per hen was $2.06.

INHERITANCE IN EGG PRODUCTION

The results of breeding high dams to low sires and low dams to low sires is shown in the pullets of one test. These pullets first year's production were as follows: The high dams average 180 eggs each per year. The daughters sired by a low sire average 99.3 in their pullet year. The low dams laid 90.8 eggs per hen per year. The daughters sired by the same low sire averaged 90 eggs each per year.

THE COST OF PUTTING PULLETS INTO LAY

The chicks in this test were hatched March 13, 1927, and were Single Comb Rhode Island Reds. The pullets began to lay on August 12th at the age of five months. The cost of feed from hatching until they commenced to lay was $57.61 for 100 pullets. It required $6.97 for kerosene for brooding. The cost of the chicks was $20.00, making the cost per pullet of $0.8458.

DURATION OF THE CARRIER STAGE OF BACILLARY WHITE DIARRHEA

Studies on flocks of carrier birds show that respiration is not noticeably affected. There may exist temporary elevations of temperature. The annual body weight curve follows that of normal birds. There is a distinct tendency to nest more often than normal birds. The death rate in carrier flocks is abnormally high and the blood structure of the carrier bird is that of a mild leucocytosis of the polynuclear variety.

Carrier birds may be profitable from an egg production standpoint during the pullet year. This varies among individuals according to the severity of the infection.

In reference to the efficiency of the agglutination test in detecting carrier birds it was shown that, in flocks of reactors studied, the agglutination test would remove 90 per cent. of the carriers if applied at any time in one flock of 29 reacting birds held for 14 months. It would have removed 98 per cent. of the carriers in an infected flock of 21 birds studied for 6 months if applied at any time. It would have removed 98 per cent. of the carriers of avian typhoid in a flock of 50 birds studied six months if applied at any time during that period. There is a cross agglutination between S. pullora, the causative organism of bacillary white diarrhea, and E. sanguinaria, the causative organism of avian typhoid.

In further confirmation of the reliability of the agglutination test 529 birds condemned by the North Carolina State Department of Agriculture as carriers of the disease were killed and examinations made for pathological lesions. Post mortem examinations confirm the positive agglutination test by pathological lesions in 92.9 per cent. of 362 hens and 69.6 per cent. of 135 pullets. The ovaries are the principal site of focalization of the disease in birds of both classes. In hens the heart structure showed alternations in 14.7 per cent., while involvement of this organ was found in 25.5 per cent. of the pullets. The causative organism was isolated from 70.3% of the hens and 57.4 per cent. of the pullets. The heart structure

of two of five males examined showed the presence of the organism. The organism was recovered in one instance from a large cloacal cyst.

The intermittent reactor phenomena was studied in two instances and it was found that these birds did not entirely throw off the disease even though the agglutination test proved negative for long periods of time. In one instance a bird showed a negative reaction for five months and laid eight eggs in the fifth month, four of them containing S. pullora.

SEPTICAEMIC DISEASES AMONG FOWLS WITH SPECIAL REFERENCE TO BACILLARY WHITE DIARRHEA

While the disease produces a septicaemia in chicks, it terminates in the form of a focal infection in the adult birds which throw off the disease as chicks. Adults are readily infected with a virulent strain of the causative organism, S. pullora, the incubation period varying from four to seven days. Agglutinins against the disease are produced in from 12 to 18 days. There is usually a well pronounced elevation of temperature and accelerated respiration. Blood studies show a leucocytosis which persists until focalization of the disease occurs.

Bacterial examination of eggs laid by carrier birds shows that in 1313 eggs laid by a pen of Single Comb Rhode Island Reds there was 7.31 per cent. infected with S. pullora. In 2505 eggs laid by Leghorns the infection per cent. was 5.23. The total per cent. of infected eggs as brought out in this investigation was 5.94 per cent. of 3817 eggs examined.

Mortality from S. pullora infection commences in the shell. Forty-eight of 175 chicks, or 27.4% of the total number of chicks dead in the shell on the 21st day of incubation of eggs from carrier birds revealed infection with S. pullora. In comparison with this figure only four, or 0.004 per cent. of 1,000 chicks dead in the shell on the 21st day of incubation in hatcheries using only eggs from blood-tested stock showed the presence of this organism.

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Head, Poultry Department.

DEPARTMENT OF BOTANY

DIVISION OF PLANT PATHOLOGY

S. G. Lehman, *In Charge*

A brief statement of the progress of the work conducted by the Division of Plant Pathology in the study of the nature and control of plant diseases during the past year is herein presented.

Soybean Diseases. Studies of the Cerospoŕo disease of soybean ascribed to *Cercospora Daizu* Muira are nearing completion. A paper setting forth the results of these studies is now in course of preparation. This disease, originally found in Currituck County, is now known to be widespread in the State. The chief symptom is a spotting of the leaves and when infection occurs in some susceptible varieties the area effective for photosynthetic production of carbohydrates is often greatly reduced. The value of the leaves for forage and the yield of beans on infected plants decrease with increase in severity of the disease.

The presence of another disease due apparently to a second species of Cercospora (probably *Cercospora kikuchii*) has recently been discovered in the State. This fungus grows between the layers of the seed coat and on light colored seeds produces a purplish or lavender discoloration. The infected bean appears to be sound, but the discoloration gives it the appearance of a hybrid and for that reason is undesirable to the producer of pure strains of varieties with light colored seeds. Our information regarding this disease is as yet very meager but observations will be continued with a view to learning more of the life history of the parasite and the nature and control of the disease.

In an effort to determine the value of seed treatment in control of seed-borne diseases of soybeans Mammoth Yellow seeds from plants diseased with mildew (*Peronospora manshurica*) and bacterial blight (*Bact. sojae*) were treated with various chemical disinfectants. No mildew developed on either treated or untreated seed. Bacterial blight was absent from most of the treated lots but appeared in very moderate amount on plants from untreated seed and from certain of the treated lots. While it is believed that the treatment reduced the amount of the bacterial blight disease, no satisfactory conclusion can be drawn from the test owing to the fact that development of the disease was greatly hindered by the unusually dry weather which prevailed during the time the beans were growing.

The tests to determine the effect of various disinfectants on the germination of soybean seed have been continued using seed of the Mammoth Yellow and Biloxi varieties. Formaldehyde when used in such concentrations and for such periods of time as would be effective in killing seed-borne parasites reduced the germination of the seed. Mercuric chloride reduced germination slightly in some tests but not in all. The organic mercuries, such as Semesan and Uspulun, showed no injurious effects. These materials can undoubtedly be used on the above mentioned varieties for reasonable lengths of time without fear of injury to germination.

Soybean and Cowpea Wilt. Comparative tests are being made with strains of wilt producing fungi isolated from cowpea and soybean. In farm practice it is important to know if one can safely substitute soybeans for cowpeas on land where cowpeas die of the wilt disease. Pot cultures on Norfolk sandy loam indicate that blackeye cowpeas are more readily attacked by Fusaria isolated from wilted cowpea plants than by Fusaria obtained from wilted soybeans. On the other hand under the same test conditions neither the strains isolated from soybean nor cowpea produced wilt of soybean. It appears that the soybean plant is markedly more resistant to wilt producing Fusaria than is the cowpea. When Norfolk sandy loam was compared with coarse sand a much greater number of cowpea plants succumbed to wilt on the latter than on the former soil. There appears also to be a positive relation between the amount of root infestation with larvae of the bean beetle and the amount of wilt which develops on cowpea when grown on infested soil. A number of soybean plants likewise showed root infestation with bean beetle larvae, but none of these plants, although growing on coarse sand inoculated with Fusaria from wilted cowpeas, showed infection with the cowpea wilt fungus.

Control of Seed-Borne Infection. The work of this project has been carried on in co-operation with Mr. Kime of the Department of Agronomy. Owing to inability to obtain seed infected with anthracnose no data on control of this disease has been obtained, however, the work has yielded information relating to the effect of different seed treatments on germination and has served to emphasize the matter of high mortality of cotton seed and seedlings under average planting conditions in the field. This frequently amounts to the surprisingly high proportion of one-half or two-thirds of the seed planted. While certain of the factors causing this loss are known it is believed that other causes not heretofore considered play a prominent part in the death of so many seed and seedlings.

Wheat Rust. This is a co-operative project with the office of Cereal Investigation of the U. S. Department of Agriculture, the Department of Agronomy and the Department of Botany of this station. A large number of varieties and selections were planted on the Mountain Branch Station Farm at Swannanoa and the farm of Mr. J. J. Key near Marshall. Data thus far obtained indicates the possession of marked resistance to leaf rust by certain hybrid selections of known parentage as well as by one of a number of selections made at Swannanoa from one of the beardless wheats commonly grown in this State. The results already give promise of a better wheat for North Carolina.

STATION RESEARCH PROJECTS OF R. F. POOLE

A Study of Dewberry, Leaf, Cane, and Root Diseases. The project on dewberry disease control has been continued along the same lines and from the point where Dr. Wolf left them. In studying the causes of cane and leaf blights there appears to be marked irregularities in the appearance and importance of leaf spot diseases. As an example, anthracnose was more or less severe during the 1925 season, and to some extent in 1927, but occurred in only a few fields during 1926. For the past two seasons blotch, or brown spot caused by *Cercospora rubi* Sacc. has been

prevalent throughout the dewberry areas, resulting in severe defoliation, and in some fields a definite cane blight. Bordeaux mixture (4-4-50) gave satisfactory control of the leaf spot. Only one heavy spray was applied the first of October after much infection had already taken place, but there was greater and superior cane growth on the treated plants in comparison with those left untreated, since the defoliation was complete on the latter before the end of the growing season. The harvest of berries from sprayed and unsprayed plants were not comparable on account of losses due to other causes developing just before the picking season.

A New Dewberry Root Rot. A new disease and one that may upset the economic production of the dewberry industry has been observed in a large number of fields throughout the sandhills. The disease affects the roots, stems, and underground parts of canes, and as a result the canes show poor vigor, and frequently give unprofitable yields. The diseased plants are easily spotted during the autumn and spring seasons, because the canes on diseased roots rarely attain growth equal to that of healthy roots. The disease is caused by *Collybia dryophila* Fr. This fungus has been reported from many parts of North Carolina and throughout the world. It is found in woods, growing on pine needles, and on oak stumps, but has been, heretofore, considered a saprophyte. The wild Southern dewberry and the Southern blackberry have been inoculated successfully.

The causal fungus has been studied in detail, and articles describing the disease, the causal organism, and the development of the organism in pure culture have been recently submitted to the Journal of Agricultural Research, Elisha Mitchell Journal and Mycologia, respectively.

In 1926 a badly infected field of a Lucretia dewberry planting was obtained through the courtesy and co-operation of Charlie Hunter on his farm at Cameron for control studies. In this experiment sulfur, lime, semesan, mercuric chloride, uspulum, coronoleum, phenoco, lysol, calphene and formaldehyde were used. These substances were used in various strengths, and applied in both liquid and dust form. The dry compounds like sulfur and lime were mixed well with the soil around the infected stems. The mercuric chloride, semesan, formaldehyde, phenoco and others were prepared in solutions, which were poured around the stems into a small cone shaped mound built around each plant so that the solution would be placed in contact with all parts of the stem. After applying the solutions the soil was pulled in toward the stems in such a way that the solutions were forced to rise and saturate the soil around all parts of the stem and old cane spurs. The chemicals were applied in July, 1926, and again in April, 1927.

The effects of the different chemicals on the disease and the plant are given in Table I. The plants treated with surfur at the rate of 300 pounds per acre grew well throughout the summer, but began to die during October and November. This loss was due to high acidity. The original soil reaction before treatment was PH 4.5 to 5.5. When the sulfur was applied, the soil reaction became PH 3.5 to 4.0. In May, 1927, there was still this acid around plants where sulfur was applied the previous year. On lime plots the cane growth was excellent, while only eight per cent. of the plants showed diseased symptoms in comparison to 45 per cent. on untreated plots. Where lime was used the symptoms were prob-

ably being delayed by the development of a soil PH of 7.0 to 7.2 which was shown in laboratory tests to be unfavorable to the growth of the organism. The control value of lime, like other treatments, will not be fully determined for at least two more years, since the disease is confined to the stems and roots and the results must be determined largely by the comparative condition of the plants on treated and untreated plots. There are less diseased plants on plots treated with mercuric chloride, calphene, and formaldehyde than on untreated plots. The phenoco, lysol, and coronoleum caused severe injury; the new canes were destroyed and a few of the plants were killed, while most of the root stock produced

The Effect of Various Disinfectants on the Dewberry Plant and the Control of Root Rot

Chemical	Strength per acre pounds	Condition of Plants May, 1927	Condition of Plants August, 1927	Plants Showing Symptons per cent.
Sulfur	300	Slight injury, plants wilting	All plants killed	All plants killed
Lime	1000	Excellent growth	Excellent growth	8
Semesan	77.0	Slight injury	Fair growth	30
Mercuric chloride	7.7	Excellent growth	Excellent growth	21
Coronoleum	77.0	Severe cane injury. Some plants killed.	Some of injured plants had produced new canes.	25
Phenoco	77.0	Severe cane injury. Some plants killed.	Some of injured plants had produced new canes.	28
Lysol	77.0	Severe cane injury. Some plants killed.	Some of injured plants had produced new canes.	22
Calphene	77.0	Excellent growth	Excellent growth	19
Formaldehyde	77.0	Excellent growth	Excellent growth	17
Cyanamide	300	Excellent growth Slight leaf burn.	Excellent growth	35
Check	.....	Excellent growth	Excellent growth	45

new canes in 1927. The healthy new canes that were produced on some of these plants indicated that the causal fungus was destroyed, but the toxicity and loss of production for a season, which was the case in these tests, would make the use of these chemicals economically unsound, even should they control the disease. Cyanamide used at the rate of 1000 pounds per acre had no effect on the disease but caused slight leaf burn during June. In August 1927 the new canes on the same plants did not show a repetition of the leaf injury. Plants which received 100 pounds per acre did not show leaf injury at any time.

The results obtained to date have shown two important sources of infection and dissemination. The most important dissemination from one farm and locality to another is by means of diseased plants, which are readily obtained from the badly infected areas. The greatest source of field spread is by means of contaminated shears used in cutting out old canes, and is due to the fact that pruning is done during the time that the mycelium and rhizamorphs are very prolific and active on the canes

and stems. Lime applied in the hill has reduced the presence of symptoms, due to the formation of a soil medium unsuited to the growth of the causal fungus. Mercuric chloride, formaldehyde, and calphene have some control effects on the fungus, and have not produced injury in the strengths used.

Sweet Potato Diseases with Special References to the Prevention of Field Infection of Fusarium Batatatis. In studying the stem rot disease over a period of years it has been quite noticeable during many observations that a heavy stem rot infection and kill in the field frequently took place from fifteen to twenty-five days after the plants were reset. This was greatly strengthened as a fact when inoculations were made on the Yellow Jersey in pots. The symptoms of stem rot were noted in seven days and nearly all inoculated plants were diseased in ten days, but infection did not always mean immediate death to the plants. The kill was more or less irregular, even when all plants were heavily inoculated; some plants remained alive for three months after becoming infected and sometimes produced a crop of potatoes. But the significant loss occurring in most fields soon after the plants were reset is certain to be due either to the use of diseased plants grown on diseased potatoes or to contaminated plants. In examinations for disease symptoms it was thoroughly demonstrated that it was not easy to diagnose slightly diseased plants in the plant bed, and at the same time few beds have shown severe plant infection. Furthermore, in a good many cases heavy losses from stem rot are known to occur in fields following the use of seed stock and sprouts certified against stem rot, but in no case was field infection as pronounced as when plants were handled in such a way that contamination was attained. These findings strongly indicate that the potato is not the present serious source of stem rot infection. This leaves open two sources; the soil and the air from which contamination takes place between the time the plants are pulled from the plant bed and reset into the field. The latter appears to be the most important source of infection, where plants become contaminated, since 100 per cent infection is easily obtained by inoculating broken stems while total infection is rarely obtained when plants are set in infected soils.

As a result of the studies on the sources of infection, the causal organism *Fusarium batatatis* of stem rot was studied in cultures containing various strengths of disinfectants, with some promising results. A sweet potato medium containing 200 grams of sliced Yellow Jersey sweet potato in a liter of water was used. The sweet potato was boiled until well done, strained through cheese cloth and either tubed or placed into 100 and 200 cubic centimeter flasks in the amounts needed. In the flasks the amount used for most tests was 25 cc. To this was added the pure chemicals in carefully weighed and measured amounts. The medium was sterilized, then inoculated with *Fusarium batatatis* which had been used in previous inoculations with positive results. Records were kept of the growth in each replication and at the end of eight weeks the final readings were made of the strength limiting growth, which was easily determined by examining the culture, for visible growth.

In these tests the growth of *Fusarium batatatis* was inhibited in solutions of formaldehyde 1-1000, copper sulphate 1-600, semesan 1-1500, phenoco 1-1500, coronoleum 1-1500, and mercuric chloride 1-700. It is more or

less obvious from these results that any of the chemicals used in the cultural studies would economically inhibit the growth of the organism on the potato plant provided their strength could be maintained on the roots of the plant during the infective periods.

In the beginning having a large number of satisfactory chemicals controlling the fungus in dilute solutions, was a distinct asset in carrying out pot and field tests under natural soil and field conditions. For the pot studies, sand was secured from washed areas on the college farm. It was placed in two gallon stone crocks, and permitted to drain freely throughout the test period. The field soil was composed of heavy and sandy loam, all tests being conducted on the college farm. The chemicals used consisted of emulsified oils known as lysol, and phenoco, mercuric chloride, organic mercury compounds, potassium permanganate, formaldehyde, calphene, copper sulphate, Bordeaux mixture, copper-lime dust, lime and sulfur. In all, ten different tests were conducted, each repeated two or more times with twenty-five or more plants. The tests were conducted with a pure culture of *Fusarium batatatis*, which was isolated in 1923 from the Red Jersey variety of sweet potatoes. The culture has been grown continuously on a sweet potato medium since that time. The inoculum was prepared from the original culture by making a new transfer culture four days before starting the experiment. The contents of two test tubes gave sufficient spore suspension in a pint of water to induce a heavy inoculation. The spores were mostly microconidia, though a few macroconidia occurred in the suspension. The Porto Rico and Yellow Jersey varieties were used; the plants being grown from healthy potatoes. The plants were pulled from the potatoes in the usual manner, and all stems were freshly cut one inch below the first roots. The roots and stems of plants were emersed in the spore suspension and immediately dipped into the disinfectant. The plants were then immediately reset in pots and in the field without washing. The tests were examined daily and records made of diseased symptoms, which occurred in seven days and afterwards. The results of pot tests are summarized in Table I. These results were probably obtained under greater disease producing conditions than will occur under field conditions, since there was a much greater kill in pot tests. The symptoms of infection were noted in seven days after plants had been inoculated July 15, while in 12 days the symptoms were definite and some plants had reached the purplish stem stage which is prominent after severe infection occurs in the bundles. In pinching away the cortex, it was shown that the brown discolored cambium, the characteristic symptom of the disease, had occurred well up in the plant, even in leaf petioles in twelve days. Copper-lime dust, a 20 per cent. monohydrated copper sulphate compound, formaldehyde and semesan delayed infection about 45 days and allowed only 20 per cent. infection in comparison to 100 per cent. infection of untreated plants. In the field Bordeaux gave complete control when used at a strength of 1-1-10. While copper-lime dust was not as effective as Bordeaux mixture in pot tests when used as heavily as wet roots would hold, it gave control in the field. This may indicate that a protection is needed for only a short period under field conditions, since a greater degree of control was obtained in the field than in pots. The same was true of mercuric chloride, formaldehyde, semesan, and Bayer Dust, which delayed the infection and

gave some control in some field tests but showed very slight control in pots. It is obvious that sulfur, potassium permanganate, phenoco, and lysol are ineffective, since the symptoms of the disease were soon noted on treated plants and the loss was equally as great as of untreated inoculated plants. In two tests in which calphene dust was applied to wet

Table I. The Effect of Disinfectants on the Control of Fusarium Batatatis on the Roots and Stems of Sweet Potatoes

Treatment	Strength Used July 15	Stem Rot Infection Per Cent.			
		July 27	Aug. 1	Aug. 13	Sept. 1
Copper-lime dust	1-10	0	0	40	90
Bordeaux mixture	1-1-10	0	0	0	20
Formaldehyde	1-100	0	10	60	100
Semesan	1-100	0	0	10	100
Mercuric chloride	1-200	0	40	40	70
Lime	1-10	20	20	90	100
Lysol	1-100	20	80	90	100
Phenoco	1-100	40	50	70	100
Sulfur	Saturated	70	90	90	100
Calphene	1-100	60	100	100	100
Potassium Permanganate	1-100	80	100	100	100
Check	Inoculated	80	100	100	100
Check	Uninoc.	0	0	0	0

roots, greater control was obtained than when the compound was applied in solution, probably due to greater concentration of chemical on roots when used as a dust on wet roots.

The injurious effects of the chemicals used in these studies have not been fully investigated. These studies were made under optimum conditions for plant growth. In the field and in pots sufficient water was available for best replanting. Furthermore, the roots were maintained moist during the interval between removal from plant bed and resetting in the field. No injury occurred under these conditions when copper-lime dust and Bordeaux mixture were used in the strengths given above. Phenoco, lysol, potassium permanganate, semesan, Bayer dust, mercuric chloride, copper sulphate, formaldehyde, and calphene caused injury, but formaldehyde, semesan and Bayer dust were only slightly toxic, and are certain to prove unsatisfactory under field conditions.

Sweet Potato Diseases in Storage and Transit with Special Reference to Their Control with Chemical Treatment. Recent studies made in storage houses in this State have given some interesting figures on the occurrence of sweet potato diseases. In some storage houses, the loss due to diseases during the past two years has averaged from 25 to 50 per cent. In others, mostly new houses, which had not become contaminated, the loss has not been very great. A very large percentage of the losses were the result of a late harvest in which the potatoes were severely injured by frost and became infected with parasitic fungi while in the soil; and to growing the crop on heavy soils, where ripening was greatly delayed and the potatoes had to be stored while with a high starchy composition. The losses in the houses were due to well-known fungi *Diplodia tubericola, Fusarium oxysporum, Rhizopus nigricans, Ceratostomella fimbriatum, Trichoderma koningi, Sclerotium bataticola,* and *Diaporthe*

batatatis. The greatest loss was due to diseases caused by *Ceratostomella fimbriatum*, *Fusarium oxysporium*, *Diplodia tubericola*, and *Sclerotium bataticola*. At one house in the eastern part of North Carolina more than five carloads of potatoes decayed with the charcoal disease caused by *Sclerotium bataticola* and were thrown out. At another house several carloads of potatoes affected with black rot, caused by *Ceratostomella fimbriatum* were a complete loss. Soft rot caused by *Rhizopus nigricans* is widespread and is causing very heavy damage to potatoes in storage houses and banks. Although potatoes have been well cured in some houses, heavy losses have frequently developed in transit, because the present method of curage does not make immunity. Furthermore, there are thousands of growers in this state who cannot afford to build storage houses. A very large percentage of the farmers of the state grow sweet potatoes on small areas, for home consumption, which would not warrant the erection of storage houses. A greater economical means of preserving the crop is a present urgent need, which has prompted a study of chemical protection.

Studies on the effects of non-poisonous disinfectants on the keeping qualities of potatoes in storage and in transit were conducted with the view of protecting potatoes against the ravages of the fungi that cause the many different rots under the various storage conditions. The chemicals used to date consist of copper-lime dust, Bordeaux mixture, copper carbonate, copper sulfate, calcium oxide, calcium hydrate, lysol, phenoco, potassium permanganate and formaldehyde. In the laboratory, formaldehyde, calcium oxide, phenoco, and copper sulfate were used in pure culture studies. The medium used is the same as that described under the prevention of field infection. Furthermore, the same procedure was followed throughout all chemical studies. The limiting range of growth of three of the most important parasites were determined on some of the chemicals given above. The inhibiting growth of *Rhizopus nigricans* with calcium oxide at a strength of 1-300 is of particular significance, since the control is due to a high hydroxyl reaction, and is entirely economical and practical. Growth of this fungus was also inhibited with phenoco 1-5000 and copper sulphate 1-1000. The growth of *Ceratostomella fimbriatum* was inhibited with phenoco 1-6000 and copper sulphate 1-700 and the same strength of copper sulphate prevented the growth of *Sclerotium bataticola*. The results obtained in these culture studies indicate that a great many chemicals are possibly excellent disinfectants for fungi that rot the sweet potato, but do not indicate what effect they will have under practical applications.

Laboratory control tests were conducted with Rhizophus nigricans. The Porto Rico, White Yam, and Yellow Jersey varieties of sweet potatoes were used. The potatoes were split in half, emersed in the disinfectant, heavily inoculated with a three day old culture of the fungus, and placed on cheese cloth with cut surface down. This was previously found to be a means of obtaining maximum infection. When dust compounds were used, the freshly cut surface was completely covered with the chemical, but always maintained moist. The average results of a test conducted January 21 to February 1 are given in Table I. Infection was readily obtained and the diseased symptoms of soft decay were observed in twenty-four hours after the potatoes were inoculated and distinct decay was observed on the second day. Copper carbonate, Bordeaux mixture, and

a 20 per cent. monohydrated copper-lime and calcium oxide prevented infection. All other chemicals had little or no control effect on the infection. When the limed surface was maintained on a moist cloth, 22 per cent. of the potatoes rotted. The chemicals were used much stronger in these tests than in the culture studies. This was advisable in view of the fact that it was essential to study injurious effects.

Treatments were conducted on Porto Rico potatoes in the co-operative storage house at New Bern and at the State Hospital, Goldsboro. The potatoes were freshly harvested and treated immediately and stored in well built houses for this purpose. When solutions were used the potatoes were dipped and stored immediately without drying. When the substances were used dry, the potatoes were rolled in the chemical dust in such a way that the entire surface was treated. The potatoes in these tests were not inoculated, but each treatment was repeated sufficiently so that the results could be comparable under natural conditions for the house. Results obtained at the end of the storage period in February are given in Table II for the test at Goldsboro. Bordeaux mixture containing eight pounds copper sulphate and the same amount of lime in fifty gallons of water, calcium oxide, a twenty per cent. monohydrated copper sulphate, mixed with eighty per cent. calcium hydrate gave complete control of surface and soft rots caused by *Fusarium oxysporium* and *Rhizopus nigricans* respectively. Colloidal sulfur, finely ground sulfur, lime sulfur, boric acid, lysol and potassium permanganate were less effective. The untreated potatoes had 61.1 per cent. surface rot, as compared with 21.8 per cent. on lime-sulfur treatments, indicating that a good many of the chemicals have some control effect on the surface rot.

The loss due to *Rhizopus nigricans* was not very great, and was worse in some containers than in others. The general averages give a loss of 5.5 per cent on untreated while the average loss on any treatment was no greater than 2.6 per cent. In some containers mice had caused injury through which the molds had developed. Most of the substances acted as mice repellants, since there was no injury where copper and lime compounds were used. The sweet potato seems to be very resistant to chemical injury, since heavy dosages were used and in no case did abrasions occur. Greater shrinkage was noted where salt compounds were used, while lime and Bordeaux mixture checked the loss of water. The mixtures as a whole were readily removed from the potato at the end of the storage period. Copper carbonate, and copper lime dust were the most difficult to rub off, but it is quite probable that this difficulty could be removed by applying smaller quantities.

Sweet potato Disinfection Studies for the Control of Seed-borne Fungi That Cause Losses in the Field. This project has received much attention during the past two years, and some definite conclusions may be obtained at the end of the present season. While a complete report will be given next year on these studies, it is advisable at this time to include a brief statement of the results obtained during 1926.

Table I. The Effect of Disinfecting Chemicals on the Control of Rhizopus Nigricans, the Cause of Soft Rot

Chemical	Strength	Infection Per Cent.		
		Jan. 23	Jan. 26	Feb. 1
Copper carbonate	Dust saturation	0	0	0
Bordeaux mixture	1-1-10	0	0	0
Copper sulfate and lime	Dust saturation	0	0	0
Calcium oxide	1-9	0	0	0
Calcium oxide	1-9	0	0	22
Sodium chloride	1-50	20	100	100
Sulfur	Dust saturation	7	54	100
Phenoco	1-100	15	61	100
Lysol	1-100	30	84	100
Potassium permanganate	1-100	0	55	100
Formaldehyde	1-120	30	100	100
Check (inoc)	.....	57	100	100

Table II. The Effect of Disinfectants on the Control of Sweet Potato Storage Rots at Goldsboro

Chemicals	Strengths	Surface Rot per cent.	Soft Rot
Bordeaux mixture	8-8-50	0	0
Calcium oxide	10 %	0	0
Monohydrated copper sulfate	4 ozs. per bu.	0	0
Copper carbonate	4 ozs. per bu.	0	0
Colloidal sulfur	3 ozs. per bu.	0	2.0
Sulfur	3 ozs. per bu.	5.1	2.0
Lime sulfur	1 lb. to 30 gals.	21.8	2.3
Boric acid	2 %	17.9	2.6
Lysol	1 %	6.3	2.5
Potassium permanganate	3 %	17.2	2.0
Check	.....	61.1	5.5

The Yellow Jersey variety, badly scurfed, was used. The potatoes were treated with Bayer Dust, semesan, mercuric chloride, and formaldehyde. The bedding of potatoes, pulling and resetting of plants was carried out in such a way as to prevent contamination from other sources than the seed potato. The results were obtained at two different periods, when the sprouts were removed from the potatoes in May and again when the potatoes were harvested in October. The results obtained at both examinations indicate that ten minute treatments with mercuric chloride 1-1000, and formaldehyde 1-240 will not control scurf when the potatoes are severely diseased. Stronger solutions of these compounds, even when used for longer periods of treatments, did not give complete control. Semesan used at the rate of 4 ounces to a bushel gave the greatest control of the chemicals used, but caused a retardation of germination and some injury. These results suggest that the safest means of obtaining scurf free potatoes is to select healthy seed.

The Relative Resistance of Sweet Potato Varieties to Heterodera Radicicola (Greef) Muller. The nematode disease is an important one in North Carolina, where a very large percentage of the field, truck and vegetable crops are susceptible to this disease. The sweet potato is probably nearly

as susceptible as any other crop, but the so-called big root stage produced by this same organism and so prominently seen on tomatoes, tobacco and other crops has not been observed on the sweet potato. In the field the disease lowers the vitality of the plant, which results in low yields. Recent studies were made in co-operation with the Horticultural Department on the susceptibility and resistance of all the well known commercial sweet potato varieties to nematode infection. The results showed that all strains of Porto Rico and Jersey varieties were so highly resistant that yields were not affected. On these varieties, the infection was very slight on the ends of roots, and on potatoes cracked by physiological conditions. The Southern Queen, Norton Yam, Yellow Yam, Pumpkin Yam, Red Bermuda and Nancy Hall varieties and related strains were severely diseased. The potatoes were so severely infected when small and the roots were so badly broken at infected areas that the yields were reduced from 150 to 200 bushels. This accounts for the poor production of the Nancy Hall and other susceptible varieties on nematode infested soils. While the Nancy Hall produced a yield of 81.7 bushels per acre on the infected soil the market quality of the potatoes was further reduced due to the fact that all potatoes were penetrated by the worms, and at harvest time the female worms, full of eggs, were abundant in all potatoes. A detailed account of these results is published in the August issue of Phytopathology.

COLLEGE RESEARCH

A Southern Upland Grass-Sedge Bog. B. W. Wells and I. V. Shunk. This study completed. Reference to summary in MS. will give an outline of project and results obtained.

An Ecological Study of the Sand Ridge Vegetation and Habitat (Coarse Sandy Uplands). B. W. Wells. An intensive study of the vegetation has been prosecuted, beginning with the pioneer plants on the white sand areas and ending with the plants transitional into the subclimax, oak-hickory forest. An ecological herbarium has been made, the plants being arranged in proper consocies sequence. Doubtful species have been personally checked at the New York Botanic Garden, and proper determinations made with the assistance of Dr. J. K. Small and others.

The desert-like habitat presents the major problem of water relations. Quantitative data has been obtained of both aerial conditions and of the water supplying power of the soil. It is the latter factor which appears to be the most important, though on the treeless areas with no shade, the local heating up of the air with concomitant elevation of the evaporation rate, constitute a factor which tends to enhance the xeric condition of the habitat.

From the quantitative work on the soil water, it would appear that the temporary lowering of the soil water supplying power in short rainless periods would in some cultivated fields bring about repression of growth, a situation that might perhaps be wrongly regarded as due to plant nutrient deficiency.

The type of native vegetation present definitely indicates the degree of the xeric conditions and this should prove of great value in passing

judgment on the probable productivity of virgin land, or land that has been long abandoned.

A Study of the Microscopic Flora of Lake Raleigh. L. A. Whitford A survey of the algal distribution in Lake Raleigh has been made, with reference to the habitat factors controlling this distribution. Certain important or dominant species have been given special attention through the study of laboratory cultures.

As a basis for comparison certain other ponds and lakes have been studied.

The data already obtained have been of value to the State Board of Health authorities. Further co-operation with this group has been effected in a study of the Neuse river between Durham and Smithfield.

Microbiological Activities in the Soil of a Southern Upland Grass-Sedge Bog. I. V. Shunk. Detailed studies have been made on the rapidity and decomposition of the organic matter in these soils. The amount of decomposition has been determined, using as an index the amount of carbon dioxide that is given off by the soil under different treatments. Correlated with these studies, the changes in numbers of bacteria, actinomyces, and fungi have been followed, as well as changes in the nature of the nitrogen content of these soils.

Since no legumes grow on this bog, and the soil is too acid to permit the activity of the aerobic nitrogen-fixing bacteria, (Azotobacter spp.), the source of the nitrogen in these soils has been studied. It was found that a great part of the nitrogen must have been fixed by anaerobic nitrogen-fixing bacteria, (Clostridium pastorianum), since these organisms have been found three or four times, and are undoubtedly quite commonly present.

These studies are pointing the way to further significant work on the bog soils, as well as soils with high organic content, such as the muck lands of Eastern North Carolina.

A Microchemical Study of Cotton Fiber Cell Walls. D. B. Anderson. The object of this investigation, now in progress, is to determine the chemical and physical structure of the cotton fiber cell wall. The following points have been established to date:

The cell wall may be divided into three distinct component parts:

1. A thin outer layer of fatty substance.
2. Cellulose deposits.
3. A thin inner layer containing protein, probably dried protoplasm.

This investigation has concerned itself primarily with the second division above, the thick cellulose deposits. Here a very definite stratification occurs, becoming visible under certain treatment. The cellulose deposits are composed of numerous extremely fine lamellae. The number of lamellae has not been definitely determined because of difficulties involved. Very probably the number of lamellae is not constant in different fibers, but varies over a wide range. The number of lamellae in an average cotton fiber is large—certainly more than 20—probably twice or three times that number. Efforts to separate these lamellae completely from one another in order to study their structure have been unsuccessful. The lamellae are composed of unmodified cellulose. There is no evidence of cementing material between them. There is evidence to indicate that each lamella is *not* formed as a result of daily growth period.

The cause of the visible stratification in the fiber wall has not been determined. It is *not* the result of an alternation of cellulose with hemicellulose or pectic lamellae. *Probably* it is *not* the result of differences in water content of different cellulose lamellae. It seems possible that the stratification may be the result of visible contact surfaces between the lamellae, though this view is as yet unproven.

The lamellae composing the cellulose wall are themselves composed of spiral fibrillar units. These spiral units are anisotropic and crystalline. The shape of the crystals suggests the orthorhombic system.

Efforts to determine the direction of the fibrillar units in successive lamellae have not been successful. This must await the development of a method to completely separate the lamellae from one another. There is some evidence that the fibrils change the direction of their spiral in difference lamellae of the same fiber.

The matters at present under investigation are as follows:

1. The cause of the stratification.
2. Development of a method of separating the cellulose lamellae completely from one another.
3. Determination of the direction of the cellulose crystals in successive lamellae.
4. Determination microchemically of the presence or absence of phosphotides *in* the walls of raw cotton fiber.

Note:—The writer does not mean to imply that all the facts mentioned in this abstract are original discoveries resulting from this investigation.

Respectfully submitted,

B. W. WELLS.

ZOOLOGY AND ENTOMOLOGY

On the whole, the research work in this department has progressed very satisfactorily during the past year. Our chief handicap has been that we have not had the necessary force to carry on the work in the field:

Biology of the Leaf Hopper. Practically all of the time devoted to this project during the past year has been devoted to a survey of the damage done by the apple leaf hopper in the mountains of the State, to a brief survey of the leaf hopper in pasture lands, with most of the time being devoted to a study of the potato leaf hopper as a pest of cotton, soy beans, and peanuts. An experimental plat was established at Tarboro and five different types of dust insecticides were used against this insect. The results of these experiments can not be determined until the end of the season.

On soy beans it was observed last year that certain varieties were much more susceptible to the attacks of this insect than others. This year several careful counts were made of the number of nymphs on 100 leaflets of three different varieties. The average of these counts showed six nymphs on 100 leaflets of Herman, 220 nymphs on 100 leaflets Mammoth Yellow and 220 nymphs on 100 leaflets of Biloxi. These results are substantiated by numerous field observations in various parts of the State.

The potato leaf hopper did widespread damage to the potatoes in the northeastern part of the State and in the upper Piedmont. Late in the season the cotton was severely damaged in Wake, Nash, Edgecombe, and Wayne counties, by another species of leaf hopper that seemed to confine its attacks to the new growth. All three of these species of leaf hoppers should be studied more intensively this next year to see if a satisfactory and practical remedy for their control cannot be devised.

Z. P. METCALF, Leader.

The Tobacco Flea Beetle. Tobacco trap beds, tight beds and ordinary pole beds were constructed at the Tobacco Branch Station, but unfortunately, these beds were built late in the season and the seed sown in a very dry season so that there was not a satisfactory stand of plants and no satisfactory conclusion could be drawn. This work should be continued with similar experiments at Oxford and Rocky Mount next year.

Z. P. METCALF, Leader.

The Corn Root Worm. The rotation experiments for the control of the corn root worm were continued at the Pender Branch Station. The spring inspection in 1926 showed that the continuous corn was damaged to the extent of 43%. The corn on the 2-year rotation 21%, and on the 3-year rotation 29%. Corn harvested in the fall of 1926 showed the continuous corn with a yield of 393 lbs. corn and stover, 204 pounds corn on the ear; corn on the 2-year rotation showed corn and stover 519 pounds with 285 pounds corn. The corn on the 3-year rotation showed corn and stover 468 pounds, corn 250 pounds. The spring inspection in

1927 showed for the continuous corn 34% injury by the corn root worm, in the 2-year rotation 8% injury and the 3-year rotation 5% injury. This project should be continued another year as any conclusion that could be drawn from our present data would be very incomplete.

Z. P. METCALF, Leader.

The Corn Ear Worm. This project was being conducted in co-operation with the Division of Cereal and Forage Insects, Bureau of Entomology, and especially with their field station at Columbia, S. C. Since this field station has been abandoned, this project has been temporarily suspended.

Z. P. METCALF, Leader.

The Inheritance and Racial Distribution of the Blood Groups. During the past year special emphasis has been laid on the relation of the blood groups to other human hereditary characters. A study has been made of the relation of the inheritance of the groups to eye-color, direction of hair-whorl in the occipital hairs, malaria, mental diseases, etc. This study must be continued over a long period of time in order to obtain statistically significant results. The medicolegal applications have been worked out and published. The distribution of the groups among several new races has been established. Every step in this problem opens up new possibilities so that the project should be continued as a major project.

L. H. SNYDER, Leader.

Wintering of Bees. During the fall of 1926 the bees in twenty colonies were weighed and recorded to the half ounce. The number of bees was ascertained by multiplying the weight by the number of bees in a pound or 4800. In the following spring the bees in the same colonies were weighed again and loss and gain comparisons made. A record on 35 colonies including the above was secured both in the fall and spring on the amount of brood found in each colony and the amount of food in a hive at each season of the year; the loss in weight represented the amount of food consumed during the winter period. Also the 35 colonies were weighed during the winter at different intervals to determine the loss or gain during that particular interval. Notes were kept on general conditions that influenced the bees during the wintering period.

As this is a continued project a great deal of time was given toward co-ordinating the data secured the previous year.

F. B. MEACHAM, Leader.

A Survey of the Honey Producing Plants of the State. This project was continued from the past year because the results will vary yearly depending upon climatic conditions. This makes it necessary to secure data for several years so as to reach an average conclusion, thus enabling us to advise the beekeepers concerning certain practices that depend upon the honey plants; their blooming dates and yield of nectar or pollen for their success.

During this year a great amount of interest in this project has been shown by the beekeepers. A complete list of important honey plants of the Piedmont section has been secured with their blooming dates and

remarks concerning their respective value for honey and pollen. About 200 important beekeepers located over the State have been advised of the importance connected with such a survey and have been requested to keep a record of the honey plants in their locality. When their records are collected some valuable data should be secured.

F. B. MEACHAM, Leader.

Bees in North Carolina. During the past year collecting trips have been made from time to time whenever there has been an opportunity, laying special emphasis upon flower records. Certain of the bees are restricted to a few or even one species of plant from which they collect pollen, and consequently cross-fertilize; others visit a wide range of plant species. Conversely, some flowers are visited by several or many species of bees and other insects while others are visited by relatively few, upon which they may be dependent for cross-fertilization. Lists of flowers visited by the various species of bees and other insects, and lists of insects which visit the various plant species are both essential to a more complete knowledge of the relations of flowers and insects. Due to the fact that there is no comprehensive work including the species of bees of the entire country, it has been necessary for further progress, to specialize more narrowly and broaden the work geographically. The genus Megachile and its related genera has been worked on more thoroughly than any other of the bees, therefore, and much material from other parts of the country has been studied. This has resulted in correcting several mistakes of identification of bees occurring in North Carolina, and in a more thorough knowledge of bees of this genus, including their potential economic importance either as injurious or benefical insects. Identification of bees of other genera occurring in this State is dependent either directly on specialists in other groups or on their publications, regardless of where these specialists may be located.

T. B. MITCHELL, Leader.

A Survey of Animals of the State. This project should be continued as we are constantly accumulating information of value.

Z. P. METCALF, Leader.

Anatomy and Physiology of the Rat. This project has been actively pursued during the past year. Careful studies have been made of the digestive, reproductive, and circulatory system of the rat. This project should be continued another year.

Z. P. METCALF, Leader.

The Inheritance of Habits, with Special Reference to Mental Traits. This project was not actively enforced during the past year, but should be continued another year.

L. H. SNYDER, Leader.

Multiple Factors in Invertebrates. Measurements were made on several hundred pairs of insects of several species. A partial correlation was found between lengths of members of breeding pairs, but not such a sharp correlation as was found in crustaceams. The statement made by some zoologists that selective coupling is the rule among invertebrates

apparently does not hold good. Further search is being made for experimental material along this line.

L. H. SNYDER, Leader.

Swarm Control. Very little work was done on this project during the past year because of the light honey flow.

C. L. SAMS, Leader.

Apple Insect Investigations. Very little work was done on this project during the year as it was necessary for the leader to spend most of his time in other parts of the State.

C. H. BRANNON, Leader.

Insecticide Investigations. (Lime Sulphur vs. Oils for Scale Control.) Experiments on the comparison of lime sulphur and oil sprays in the control of scale insects were carried out. An attempt was made to determine the way that lime sulphur and oils kill scale and to find out why oil appears to control scale much better than lime sulphur. Evaporation tests comparing the rate of evaporation of lime sulphur at various dilutions to oil sprays at various dilutions were made. Lime sulphur solution was heated and the fumes forced into a glass cylinder sealed closely around branches of trees which were heavily infested with scale. The lime sulphur gas was left in the cylinders for a week and the scale infested branches were examined. The per cent. of dead scale were about the same as the check, therefore, it was concluded that lime sulphur does not kill by means of its gas being absorbed by the insect's body.

Attempts were made to check up on results secured from use of a wide variety of insecticides on many insect pests in the field. Many growers are willing to use materials according to directions and much valuable information has been secured in this way. Also county agents have helped greatly in giving us the benefit of their observations in the field.

C. H. BRANNON, Leader.

Methods of Demonstrating the Functions of Animals. This project has been continued throughout the year with special emphasis placed on the study of metabolism and muscular activity.

F. B. MEACHAM,
Z. P. METCALF, Leaders.

Morphology and Physiology of the Corn Bill Bug. (Master's Thesis). The purpose of this project was to make a special study of the morphology of the corn bill bug. Recognizing the great economic importance of this beetle in the eastern part of this State and also its resistance to practical control methods, the project was very interesting. Up to the time that the project was started very little morphological work had been done with the Curculionidae. With this in view, an intensive study of the detailed anatomy of this beetle was started. The external anatomy

of the adult beetle was taken up first. The many structures were separated so that they could be identified, drawn and described. The head, thorax, legs, wings, abdomen, spiracles were the major parts of the external anatomy dealt with. Minor characteristics of each of these parts were then described. Special emphasis was placed on wing folding as an important point in Taxonomy. Many interesting characteristics were found in studying the genitalia and internal anatomy of these beetles.

The results obtained were recorded by photographs and detailed descriptions and these were arranged in the form of a thesis which was presented to the North Carolina State College of Agriculture and Engineering in partial fulfillment of the requirements for the degree of Master of Science.

D. L. WRAY, Leader.

The Modification of the Germ Plasm by Means of X-Rays. Previous work with x-rays showed that, although they caused a temporary sterility in rats, no abnormalities were found in the descendants of the first litters after sterility. However, recent positive results obtained by Muller on the effects of x-rays on drosophila indicate that the critical offspring are those born from mature radiated spermia, before sterility. Consequently it becomes important to irradiate more rats, raising the early litters and inbreeding them.

L. H. SNYDER, Leader.

The Taxonomy and Biology of the Leaf-Cutter Bees. The leaf-cutter bees are those of the genus Megachile, in which a large majority of the species, probably, line their nests with pieces of leaves which they cut from various trees and shrubs, this activity sometimes resulting in the defoliation of the trees attacked. Some of them nest in the ground, some in tunnels in wood, others roll leaves and line the nests thus formed with cut pieces of petals, and still others build the nest of resinous materials instead of leaves. They collect the pollen from various flowers to store in their nests, and are thus active in cross-fertilizing many plants. They may, therefore, be either injurious or beneficial in their activities. The genus is said to contain more species than any other genus of bees except Andrena. The species are very imperfectly known, many of them having been described two or more times under different names, while many others are as yet undescribed. The habits of only a few have been observed and published upon. It is desirable, therefore, that the species be fully described and figured, that the species be grouped according to taxonomic characters, that the naturalness of these groups be checked by a study of their biology, that the geographical distribution of these groups be ascertained and that the factors governing their dispersal over the globe be learned wherever possible, that possible means of control when species become injurious or means of maintaining the species that prove to be beneficial, be developed, and that all the ecological relations such as parasitism, effect of environment, etc., be studied as fully and completely as possible, wherever and whenever opportunity offers.

T. B. MITCHELL, Leader.

The Economic Importance of Some North Carolina Birds. Two thousand wild quail, imported from Mexico, and turned loose near Greensboro, were banded before being released. This fall at the hunting season results on differential susceptibility to disease, etc., should become available.

Work has been started on a bulletin of the birds of the State, based on previous observations and study, as well as on published records.

L. H. SNYDER, Leader.

Respectfully submitted,

Z. P. METCALF,
Zoologist and Entomologist.

AGRICULTURAL ECONOMICS

PROGRESS AND RESEARCH WORK IN AGRICULTURAL ECONOMICS FOR THE DEPARTMENT OF AGRICULTURAL ADMINISTRATION

For the past four years the Department of Agricultural Administration has conducted research in farm organization in four typical areas of the State:

1. Coastal Plain (Johnston, Harnett, and Columbus counties).
2. Lower Coastal Plain (Craven County).
3. Mountain Area (Macon County).
4. Upper Coastal Plain (Northampton County).

The projects in the first two areas mentioned above have been completed. A bulletin has been published entitled "Profitable Farm Organizations for the Coastal Plain of North Carolina". In this bulletin were presented farm organizations which apparently are more profitable than those which are normally followed by farmers in the area to which the study applied. In the bulletin entitled "Profitable Farm Combinations" has been published conditions relative to the Lower Coastal Plain of North Carolina, of which agriculture in Craven County is typical. This bulletin is similar to the one mentioned above and gives typical organizations which it is believed will be more profitable than those which are now being followed by farmers in the Lower Coastal Plain.

The research in the Mountain area was completed February 28, 1927. The information has been tabulated and analyzed. This year a bulletin will be prepared and submitted for publication. In this bulletin the idea of standard farm organizations will be developed further with the object of revealing the effect of variations in prices on the character of crop and livestock combinations.

In this connection, it should be pointed out that the research work in farm organization and management has been conducted in co-operation with the United States Department of Agriculture. The department has been highly satisfied with the results and is attempting to get other southern states to adopt the same methods which have been developed at this institution.

Practices and Costs of Cotton Gin Operation in a Selected Section of North Carolina in 1924-1925. This study was conducted in co-operation with the United States Department of Agriculture during the summer of 1925. A number of cotton gins in Harnett, Johnston, and Wake counties were visited and a record of their businesses secured. The objectives of this study were: (1) to learn the kind and quality of services rendered by ginners, and (2) to determine the factors influencing efficiency in gin operation which, if generally applied, would aid in the reduction of waste in the industry. The material has been tabulated and a report issued.

Agricultural Credit Problems in North Carolina. This was a project carried on by the United States Department of Agriculture for the purpose of obtaining the following objectives:

1. Determination of current credit requirements of farmers in North Carolina and sources, conditions and costs of such credit.

2. To determine adequacy with which existing agencies extending credit are supplying farmers' needs.

3. To determine the relationship between different types of farming in the State and the amount and cost of credit used.

4. To determine the extent to which farmers are in position to offer sufficient security for credit necessary to make profitable adjustments in farm operations.

5. To determine how the basis of credit and the existing facilities may be improved.

6. To determine how or to what extent credit direct from banks and other specialized agencies may be substituted for the more expensive store and dealers' credit.

The field data for this project has been gathered and the analysis has been partly completed. A bulletin will be published on this project sometime during 1927-1928.

The Study of the Relationship of Land Values to Crop Prices, Tendency and Rate of Taxation. The information for this project was obtained in 1925. Information was secured in Rockingham, Caswell and Person counties. The information covered the period from 1880 to 1925. The data have been tabulated but the analysis of the data has not been made. This was a joint project with the Bureau of Agricultural Economics of the United States Department of Agriculture. The department has issued a preliminary report on the information, but does not anticipate the completion of the work until the end of this year.

Future Plans. Beginning January 1, 1928, the Department of Agricultural Administration will initiate what is termed farm organization and management demonstrations. This project has as its object the organization of the farm under actual farm conditions, modifying the crop and livestock combinations as future prices may be termed. Accurate records will be kept on about one hundred farms and the results will be checked at the end of each year. The United States Department of Agriculture is co-operating in this project and is planning to give assistance in organizing and carrying forward the work.

The department has also under consideration the work in the field of agricultural marketing. There are a great many problems in this field which need early attention and it is hoped that funds and personnel will be available so that the work in this field may be started during the present year.

Respectfully submitted,

G. W. FORSTER,
Agricultural Economist.

RURAL SOCIOLOGY

The study of the standard of living of farm owner operators in Wake County was begun October 1, 1926, and is now completed. The method of this study has been that of the survey in which 25% of the white land owner operators in the county have been visited, and from whom have been gathered data concerning their income and expenditures and other elements pertaining to the living standard during the year. It is hoped that the data will make it possible not only to give a description of the standard of living among the land owners, but also to indicate some of the significant factors affecting the standard.

As a companion study we are this year investigating the white tenants of the county, receiving data concerning their income and expenditures and the other elements which enter into the standard of living. When the data from both of these studies are completely tabulated, a comparative study of the living standards of the two groups will be made, and an endeavor made to discover the significant causes of differences that appear.

In addition to these two major efforts, we are analyzing the utilization of time by farmers and their wives for the purpose of examining this factor and its effect upon the general standard of living. A comparison is being made between the survey method and the detailed route method as to their effectiveness in gathering data for rural sociological analysis.

The study of national farmers' organizations, past and present, is a study in the farmers' movements in America. It includes all organizations which have sought to be national in scope; is a study of the economic, social and historic backgrounds out of which these organizations grew, the adjustments which they attempted to make, the growth, decline, and permanent influences in American agriculture.

The study of membership problems in North Carolina co-operatives is, in fact, a study of attitudes of farmers toward their own co-operative associations and toward the forces and agencies which deal with the problems which co-operative marketing seeks to solve.

The Department of Rural Sociology is concerned with three (3) chief, practical problems in the State.

(1) The standard of living of farm families and the methods by which standards of living can be improved.

(2) Community organizations, particularly those having to do with the program of work being carried out by the various agencies which function in the counties of the State.

(3) Urban-rural relations in those areas where industrialism is becoming prevalent in the State and where understanding and co-operation between urban and rural groups are essential to the welfare of rural people and the enterprise of agriculture.

W. A. ANDERSON.

LIST OF TECHNICAL PAPERS PUBLISHED OR ACCEPTED FOR PUBLICATION IN OUTSIDE JOURNALS DURING THE YEAR ENDING JUNE 30, 1927

Paper No. 13. On the Megachile of South Dakota, T. B. Mitchell.

Paper No. 14. New West Indian Megachile, T. B. Mitchell.

Paper No. 15. New Megachilid Bees, T. B. Mitchell.

Paper No. 16. Notes on the Megachilidae, T. B. Mitchell.

Paper No. 17. Studies in Human Inheritance II: The Medico-legal Application of Hereditary Human Characters, With Special Reference to the Blood Groups, Laurence H. Snyder.

Paper No. 18. Collybia Root Rot of Lucretia Dewberry, R. F. Poole.

Paper No. 19. The Nematode Disease of Sweet Potatoes, R. F. Poole and Robert Schmidt.

Paper No. 20. A Variety of Collybia Dryophila Parasitic on Dewberry, R. F. Poole.

Paper No. 21. The Fruiting of Collybia Dryophila in Pure Culture, R. F. Poole.

Paper No. 22. The Status of the Cottonseed Meal Injury Problem, J. O. Halverson.

Paper No. 23. Blood Grouping and Its Practical Applications, Laurence H. Snyder.

Paper No. 24. Studies on Gossypol II: The Elimination of D-Gossypol from Cottonseed Meal, F. W. Sherwood.